Guardian 6100 Plus
Electrical Safety Analyzer
Instruction Manual

Form 150799/A5

Domestic Sales 800-253-1230

For additional contact information please visit our website
www.quadtech.com

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Warranty

QuadTech warrants that Products are free from defects in material and workmanship and, when properly used, will perform in accordance with QuadTech's applicable published specifications. If within one (1) year after original shipment it is found not to meet this standard, it will be repaired, or at the option of QuadTech, replaced at no charge when returned to a QuadTech service facility.

Changes in the Product not approved by QuadTech shall void this warranty.

QuadTech shall not be liable for any indirect, special or consequential damages, even if notice has been given of the possibility of such damages.

This warranty is in lieu of all other warranties, expressed or implied, including, but not limited to any implied warranty or merchantability or fitness for a particular purpose.

SERVICE POLICY

QuadTech's service policy is to maintain product repair capability for a period of at least five (5) years after original shipment and to make this capability available at the then prevailing schedule of charges.

Specifications

Dielectric Strength

AC Output Voltage:	Range:	0.5 to 5kV AC, in 1V steps
	Regulation:	± (1% of setting +5V)
	Frequency:	50-600Hz, in 10Hz increments
Voltage Display:	Accuracy:	± (1% of reading +5V)
	Resolution:	1V steps
AC Current Display:	Range:	1µA to 40mA AC, in 1µA or 10µA steps
	Accuracy:	± (1% of reading + 5 counts)
DC Output Voltage:	Range:	0.5 to 6kV DC, in 1V steps
Voltage Display:	Accuracy:	± (1% of reading +5V)
	Resolution:	1V steps
DC Current Display:	Range:	0.1µA to 0.299mA DC, in 0.1µA steps 0.3mA to 2.99mA DC, in 1µA steps 3mA to 12mA DC, in 10µA steps
	Accuracy:	± (1% of reading + 5 counts)

NOTE:

The accuracy of the current reading is a function of counts in the least significant digit displayed. The magnitude of a count is determined by the current measurement range which is a function of the programmed high limit.

DC Hipot:

Programmed High Limit Current	≥ 3.00mA	1count = 10uA
Programmed High Limit Current	.300 < 3.00mA	1count = 1uA
Programmed High Limit Current	< .300mA	1count = 0.1uA

AC Hipot:

Programmed High Limit Current	≥ 3.00mA	1count = 10uA
Programmed High Limit Current	< 3.00mA	1count = 1uA

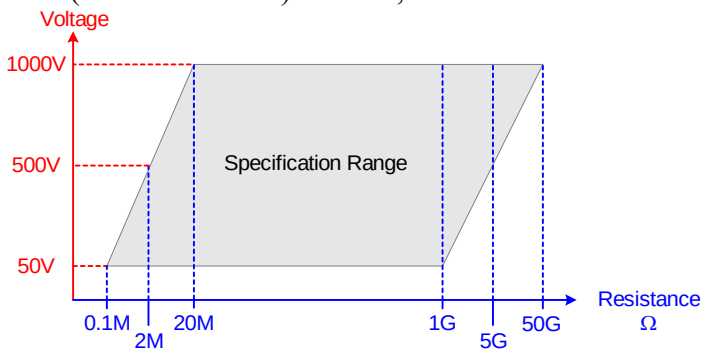
Leakage Current & Power Consumption

Input Voltage:	0 - 300V AC, 50/60Hz		
Line Voltage Meter:	0 - 300V AC, ± (1% of reading + 6cnts)		
Line Current Meter:	0.1 – 20A, ± (1.5% of reading + 0.1)		
Power:	0 – 4400VA		
High & Low Limits:	Programmable for Voltage, Current, Power or AC Source		
Current Display:	Range	Resolution	Accuracy
	0.001-0.59mA	0.0002mA	±(2% + 5cnts)
	0.6 - 10mA	0.003mA	±(2% + 5cnts)
Current Trip Limits:	0.1µA to 10mA, 1µA Resolution (Range Dependent) 0.1mA to 6.000mA for UL544NP		
Measuring Circuit:	5 Human Body Models IAW UL544 NP, UL544P, UL1563, UL2601-1, IEC60601-1, IEC 950, UL1950, UL3101 Standards		
Measurement Modes:	Normal, Reverse, Single Fault with GND ON/OFF, Earth Line Leakage, Patient Line Leakage and Patient Auxiliary Leakage.		

Specifications (Continued)

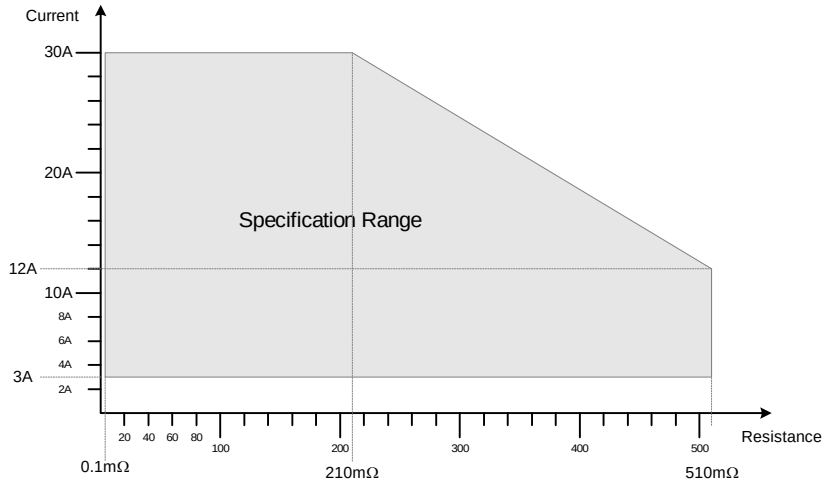
Insulation Resistance

Voltage: 50 - 1000V DC in 1V steps
Accuracy: ± (1% of reading + 5V)
Range: 100kΩ - 50GΩ (voltage dependent)
Accuracy: ± (5% + 5 counts) ≥ 500V, 10MΩ - 1GΩ
± (10% + 5 counts) ≥ 500V, 1GΩ - 10GΩ
± (15% + 5 counts) ≥ 500V, 10GΩ - 50GΩ
± (10% + 5 counts) < 500V, 100kΩ - 1GΩ



Ground Bond

Output Current: Range: 1.0 to 30.0A AC, setting .01A/step
To 40A with optional transformer (G45)
Regulation: ± (1% of setting + 0.3A)
Accuracy: ± (1% of reading + 3 counts)
Frequency: 50/60Hz, selectable
Voltage: 6 to 15V, programmable
Resistance: Range: 0.1mΩ - 510.0mΩ, 4 digits, Hi Limit
Accuracy: ± (1% of reading + 3 counts)
Resolution: 0.1mΩ



Specifications (Continued)

ARC Detection

Detection Current: Range: 1mA – 20mA AC, 1mA – 12mA DC
Pulse Width: Minimum: 40µs, 20µs, 10µs or 4µs

Open/Short Circuit Detection Mode

Detection Mode: <100V, 600Hz
Check for Open & Short against a standard capacitance value, Cs

General Features

Limits: Hi/Lo Programmable during Test Time
(Lo can be set to Off in Hipot & GR, Hi can be set to Off in IR)

Indication: Pass/Fail LEDs, audible sound
Status LEDs: Remote, Lock, Offset & Error

Display: 320 x 240 enhanced LCD with Status Indicators

Buzzer Level: Low, Medium, High or OFF

Time:

AC Hipot	DC Hipot	IR	GB
Ramp: 0.3 - 999s	Ramp: 0.3 - 999s	Ramp: 0.3 - 999s	Start Wait: 0.1 - 99.9sec
Test: 0.3 - 999sec	Dwell: 0 - 999s	Test: 0.3 - 999sec	Test: 0.3 - 999sec
	Test: 0.3 - 999sec		

Test Time is (±20ms) and can be set to Continuous
Ramp, Dwell and Start Wait Time can be set to OFF

Setup Storage: 100 memory groups with 50 steps each.
12 Character Alpha-Numeric Label

Standard Interfaces: RS-232 and Remote I/O

RS-232: Data Bits: 8, Stop Bits: 1, Parity: None/Odd/Even
Selectable Baud Rate: 300 – 19200 bps; Connector: 9 pin female

Remote I/O: Inputs: START, RESET
Characteristics: 24V active low, Pulse width >1ms
Outputs: PASS, FAIL, UNDER TEST
Characteristics: Dry contact relay, Closed if true
Electrical Characteristics: 120V, 100mA max
Connector: 9 pin male D-series & Terminal Strip

Specifications (Continued)

General Features

Internal Scanner: 6000-07 Hipot/Line Leakage Scanner: 20A Input Current

Optional External Scanner:
5000-01 Scanner: 8HV Channels
5000-02 Scanner: 8HV & 4GB Channels
5000-03 Scanner: 8HV Channels
5000-04 Scanner: 8HV & 3GB Channels

Optional Interfaces: IEEE-488 or Printer (replaces IEEE-488)

Front Panel Lockout:
Key Lock: Test and Memory recall operational; LED Display Lock
Fail Lock: Test operational; LED Display Lock
Both Lock modes are Password Protected

Connectors: Front and Rear: 4-Terminal Drive & Sense; HV OUTPUT

Mechanical: Bench Mount (optional rack mount kit available, G-43)
Dimensions:(w x h x d): 430 x 133 x 470 mm

Weight: 24kg net, 32kg shipping

Environmental: Meets MIL-T-28800E, Type 3, Class 5
Operating: 0°C to + 40°C
Storage: -20° to + 70°C
Humidity: <75%
Warm-up Time: 15 minutes

Power:
- 90 - 130V AC
- 200 - 250V AC
- 50 or 60Hz
- 800W max

Supplied:
- Instruction Manual
- Calibration Certificate
- Power Entry Adapter Cable
- AC Power Cable
- HV Lead Set
- GC Lead Set

Ordering Information:

Description	Catalog No.
Safety Analyzer	Guardian 6100 Plus

Accessories

Accessories Included

Item	Quantity	QuadTech P/N
AC Power Cord	1	4200-0300
Power Line Fuse 8A 250V SB	1	520157
Power Line Fuse 4A 250V SB	1	520053
Fuse for 6000-07 Scanner, 20A 250V SB	1	520124
High Voltage Lead Set, 1m with alligator clips	1	S02
Ground Continuity Test Lead Set with alligator clips	1	G15
Ground Continuity Power Entry Adaptor Cable	1	G14
Corded Product Adapter 115V (used for GB test)	1	G30
Power Entry Adapter	1	G33
Instruction Manual	1	150799
Calibration Certificate	1	N/A
Bushing Driver Tool	1	350256

Accessories/Options Available

Item	Quantity	QuadTech P/N
High Voltage Lead Set, high & low, 1m (std. with unit)	1	S02
High Voltage Lead Set, high & low, 2m	1	S04
Foot Switch	1	S05
High Voltage Probe	1	S06
Gun Probe	1	S08
High Voltage Lead, 1m, unterminated	1	S09
High Voltage Lead, 2m, unterminated	1	S10
Gun Probe with Remote Start	1	S11
Load Box, resistive	1	S12
Load Box, custom resistors	1	S14
Power Entry Adapter Cable, GC (std. with unit)	1	G14
Ground Continuity Lead Set (std. with unit)	1	G15
International Power Strip	1	G16
Scanner Cable (5000 Series External Scanners)	1	G24
Corded Product Adapter, 240V (used for GB test)	1	G25
Corded Product Adapter 115V (std. with unit)	1	G30
500VA Isolation Transformer	1	G31
1000VA Isolation Transformer	1	G32
Power Entry Adapter (std. with unit)	1	G33
Printer Interface (Replaces IEEE-488 Interface)	1	G38
IEEE-488 Interface	1	G39
Rack Mount Kit	1	G43
Barcode Scanner	1	G44
40A Ground Bond Transformer	1	G45
8-Channel External Scanner, 8HV Front	1	5000-01
8-Channel External Scanner, 8HV Front/4GB Rear	1	5000-02
8-Channel External Scanner, 8HV Rear	1	5000-03
8-Channel External Scanner: 8HV/3GB Rear	1	5000-04
CaptivATE© Automation Software CD	1	CAPTIVATE

Safety Precautions

WARNING

The Guardian 6100 Plus Electrical Safety Analyzer can provide an output voltage as high as 6000VDC (5000VAC) to the external device under test (DUT). Although the Guardian unit is designed with full attention to operator safety, serious hazards could occur if the instrument is used improperly and these safety instructions are not followed.

1. Operate the Guardian 6100 Plus unit with its chassis connected to earth ground. The instrument is shipped with a three-prong power cord to provide this connection to ground. This power cord should only be plugged in to a receptacle that provides earth ground. Serious injury can result if the Guardian 6100 Plus is not connected to earth ground.
2. Tightly connect cable(s) to the (black) DRIVE- terminal. If this is not done, the DUT's casing can be charged to the high voltage test level and serious injury or electrical shock hazards could result if the DUT is touched.

NOTE

For High Current Ground Bond Testing, make the connection to the DRIVE+ and DRIVE- terminals with the spade lug behind the nut. Use the Bushing Driver Tool included to secure the nut as shown in Figure COI-2.

3. Never touch the metal of the High Voltage probe directly. Touch only the insulated parts of the lead(s).
4. Never touch the test leads, test fixure or DUT in any manner (this includes insulation on all wires and clips) when the high voltage is applied and the red DANGER light is ON.
5. Before turning on the Guardian unit, make sure there is no device (DUT) or fixture connected to the test leads.
6. After each test, press the [STOP] (red) button for safety. This terminates the high voltage being applied to the output terminals.
7. When the red DANGER LED is lit or flashing, NEVER touch the device under test, the lead wires or the output terminals.
8. Before touching the test lead wires or output terminals make sure :
   a) The red [STOP] button has been pressed
   b) The red DANGER LED is OFF.
9. In the case of an emergency, turn OFF the POWER switch using a "hot stick" and disconnect the AC power cord from the wall. DO NOT TOUCH THE Guardian 6100 Plus INSTRUMENT.
   Position the equipment so it is easy to disconnect.Always disconnect by means of the power plug or power connector.
10. If the DANGER LED does not go off when the [STOP] button is pressed, immediately stop using the tester. It is possible that the output voltage is still being delivered regardless of the TEST ON/OFF control signal.
11. When the Guardian 6100 Plus instrument is remotely controlled, be extremely careful. The High Voltage Output is being turned On/Off with an external signal.

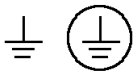
Safety Symbols

The product is marked with the following safety symbols.

 Product will be marked with this symbol (ISO#3864) when it is necessary for the user to refer to the instruction manual in order to prevent injury or equipment damage.

 Product marked with this symbol (IEC417) indicates presence of direct current.

 Product will be marked with this symbol (ISO#3864) when voltages in excess of 1000V are present.

 Indicates the grounding protect terminal, which is used to prevent electric shock from the leakage on chassis. The ground terminal must connect to earth before using the product.

Warning **P**rocedure can cause hazard to human if the warning is neglected.

Caution **A**void product misuse. It may cause damage to the product itself and the DUT if the caution is neglected.

Note Important information or tips for the procedures and applications.

Warning Signal During Testing

"DANGER – HIGH VOLTAGE TEST IN PROGRESS, UNAUTHORIZED PERSONS KEEP AWAY"

Disposal

Do not dispose of electrical appliances as unsorted municipal waste, use separate collection facilities. Contact your local government for information regarding the collection systems available. If electrical appliances are disposed of in landfills or dumps, hazardous substances can leak into the groundwater and get into the food chain, damaging your health and well-being. When replacing old appliances with new one, the retailer is legally obligated to take back your old appliances for disposal.

Condensed Operating Instructions

WARNING
High Voltage is applied to the white H.V. OUTPUT terminal anytime the red DANGER LED is ON or flashing. Always make sure the DANGER LED is OFF when connecting or disconnecting the Device Under Test (DUT).

General Information

The Guardian 6100 Plus Electrical Safety Analyzer is a measuring instrument for direct readout of Hipot output voltage and leakage current, insulation resistance and ground bond. The voltage applied to the device under test is adjustable from 50V to 5kVAC and 50V to 6kVDC. The current limit is adjustable from 1µA to 40mA AC in 1µA or 10µA steps and 0.1µA to 12mA DC in 0.1µA, 1µA or 10µA steps. PASS and FAIL LEDs provide a visual display of test results based on preset limits.

Start-Up

The Guardian 6100 Plus unit can be operated from a power source between 90 and 250VAC at a power line frequency of 50 or 60Hz. The standard Guardian 6100 Plus unit is shipped from QuadTech with an 8A fuse in place for AC 90-130V operation. (A 4A fuse is included for 200-250V operation). The G6100 Plus unit is shipped with the line voltage selector set for 120V. Refer to paragraph 1.4.3 to change a fuse and to change the line voltage selector.

Connect the Guardian 6100 Plus unit AC power cord to the source of proper voltage. The Guardian 6100 Plus is designed to be operated with its chassis connected to earth ground. The Guardian 6100 Plus is shipped with a three prong power cord to provide this connection to ground. This power cord should only be plugged in to a receptacle which provides earth ground. Serious injury can result if the Guardian 6100 Plus is not connected to earth ground.

Press the [POWER] button on the front panel to apply power. To switch the power off press the [POWER] button again or if measurements are to be made proceed with Test Parameter Set-Up below. Note: to achieve the specification accuracy, allow the G6100 Plus unit to warm-up for 15 minutes prior to use.

Test Parameter Set-Up

Press the [PROGRAM] function key
Enter the Test Parameters according to your test specification (Table COI-1).

Table COI-1: Test Parameter Set-Up

	GB	AC Hipot	DC Hipot	LC	IR	PA	OSC
1	Test Step	Test Step	Test Step	Test Step	Test Step	Test Step	Test Step
	1-50	1-50	1-50	1-50	1-50	1-50	1-50
2	Test Mode	Test Mode	Test Mode	Test Mode	Test Mode	Test Mode	Test Mode
	GB	AC	DC	LC	IR	PA	OSC
3	Current	Voltage	Voltage	Device	Voltage	Message	Open Check
	1-60A	0.05-5kV	0.05-6kV	UL544NP, 544P, 1563, 2601, 1950	0.05-1kV	13 charc	10-100%
4	High Limit	High Limit	High Limit	Line Input	Low Limit	Under Test	Short Check
	0.1–510mΩ	0.001-40mA	0.0001-12mA	Normal, Reverse, SF-N, SF-R	0.1-50000MΩ	On/Off	0, 100-500%
5	Low Limit	Low Limit	Low Limit	GB Switch	High Limit		CHNL (H-L)
	0-100mΩ	0 - 40mA	0 - 12mA	Open, Closed	0-50000MΩ		1, 3
6	Test Time	Arc Limit	Dwell Time	High Limit	Test Time		
	0, 0.3-999s	1-20mA	0-999s	0.0001-10mA*	0, 0.3-999s		
7	Twin Port	Arc Filter	Arc Limit	Low Limit	Ramp Time		
	On/Off	3-230kHz	1-10mA	0-10mA*	0-999s		
8	CHNL (H-L)	Test Time	Arc Filter	Power	CHNL (H-L)		
	OFF N/A	0, 0.3-999s	3-230kHz	V, A, VA, Source	1, 3		
9		Ramp Time	Test Time	Power High			
		0-999s	0, 0.3-999s	0-300V, 0-20A, 0-4400VA, 80-300V			
10		CHNL (H-L)	Ramp Time	Power Low			
		1, 3	0-999s	0-300V, 0-20A, 0-4400VA, 50/60Hz			
11			CHNL (H-L)	Test Time			
			1, 3	0, 0.3-999s			
				CHNL (H-L)			
				3			

* 6mA limit on 544NP Circuit Model

NOTE

Refer to paragraphs 2.4- 2.5 for a full description of programming test parameters and instruction on how to store the test setup. Test parameters must be set before the G6100 Plus unit can be zeroed.

Zeroing/Offset

After setting your test parameters, zero the Guardian 6100 Plus unit by using the automatic offset. With no device connected, connect the appropriate cable (or other fixture) into the front panel OUTPUT connectors. Refer to paragraph 2.7 for cable connections based on tests to be made. Test leads for AC Hipot, DC Hipot and IR measurements should be OPEN and test leads for GB should be SHORTED.

In MAIN MENU, press [TEST]. Press the [OFFSET] function key. A message will be shown across the TEST display: "Please short the GB port. Please open the HV output terminal. No offset in IR mode. PRESS START KEY TO GET OFFSET". Press the [START] key once. Display shows your test set-up and offset values. Offset has to be recalculated each time you change your test parameters, test leads or test fixture.

Figure COI-1 illustrates the OPEN configuration of the S02 Leads for an AC Hipot, DC Hipot or Insulation Resistance test.

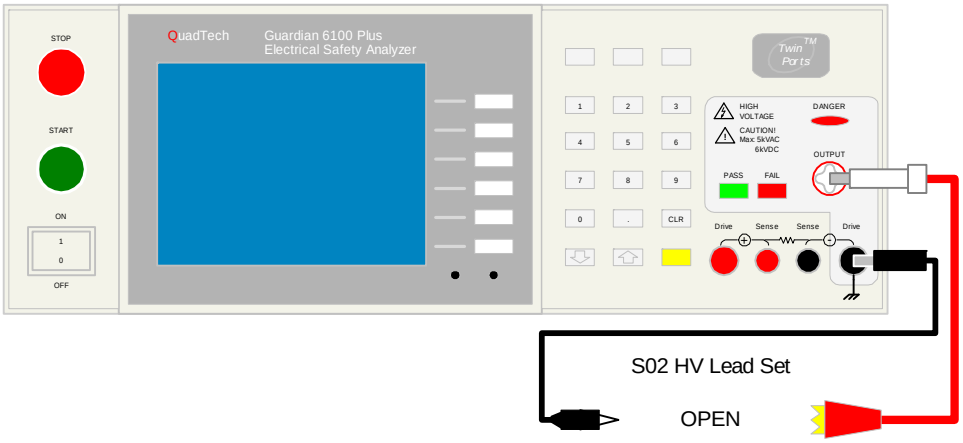


Figure COI-1 OPEN

Figure COI-2 illustrates the SHORT configuration of the G15 Leads for a Ground Bond test. Refer to ¶2.7.1, Figure 2-24 for the OFFSET conection for GB testing when using the G30 Corded Product Adapter.

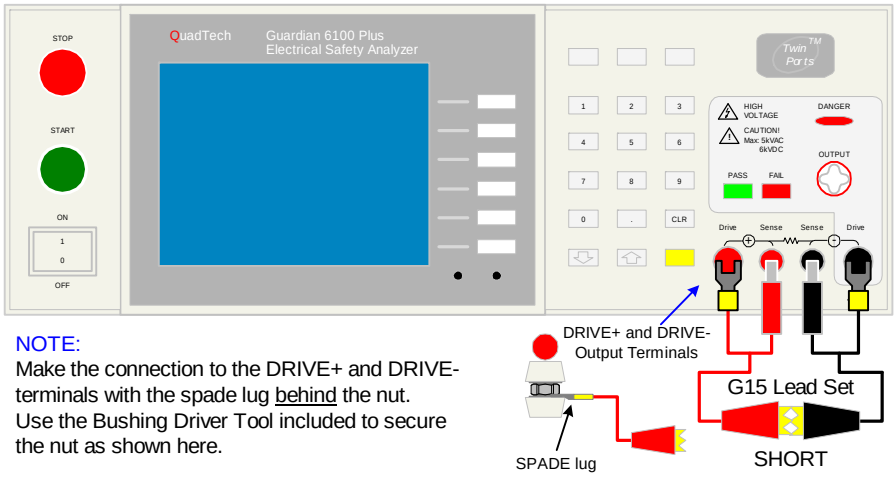


Figure COI-2: SHORT

NOTE:
If OSC is programmed, perform [GET Cs] prior to testing. Refer to ¶ 2.7.2 for detail.

Measurement Mode

The G6100 Plus Electrical Safety Analyzer is capable of measuring AC Hipot, DC Hipot, Insulation Resistance, Leakage Current and Ground Bond, plus detecting Open/Short circuits at the test terminals to verify proper connection to DUT. Refer to paragraph 2.7.3 for the appropriate cable connection to the device under test. Refer to ¶ 2.4.1-2.4.7 for instruction on programming a test.

AC Hipot Measurement Example:

1 Turn Power ON.
2 Let Guardian 6100 Plus unit warm-up 15 minutes.
3 Connect Black ground cable to G6100 Plus **DRIVE-** terminal.
4 Connect Red high voltage cable to G6100 Plus **OUTPUT** terminal.
5 Press [PROGRAM] and enter the example AC Test Parameters
6 Zero the G6100 Plus unit (OFFSET, ¶2.7.1).
7 Perform [GET Cs] (¶2.7.2)
8 [STORE] Test set-up in Memory menu.
9 Connect the Device Under Test (DUT).
10 Press red [STOP] button.
11 Press green [START] button.
12 Record Readings.
13 Press red [STOP] button.

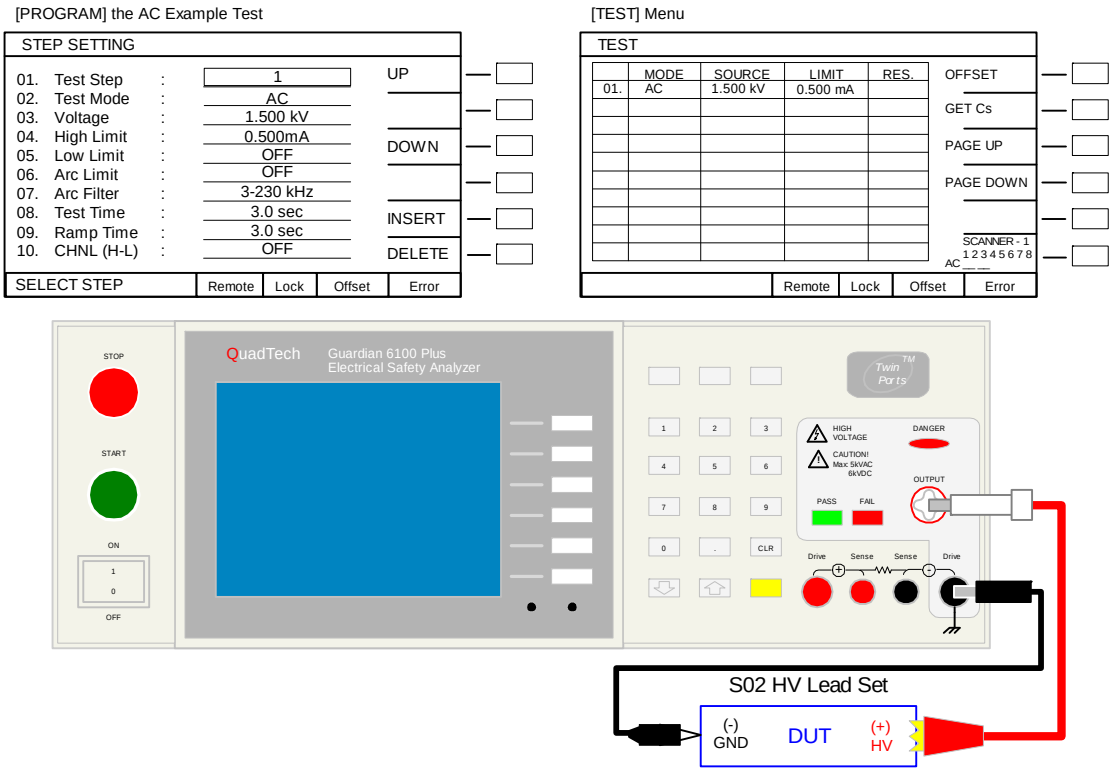


Figure COI-3: S02 Cable Connection To Device Under Test

Section 1 : Introduction

1.1 Unpacking and Inspection

Inspect the shipping carton before opening. If damaged contact the carrier agent immediately. Inspect the Guardian 6100 Plus instrument for any damage. If the instrument appears damaged or fails to meet specifications notify QuadTech (refer to instruction manual front cover) or its local representative. Retain the shipping carton and packing material for future use such as returning for recalibration or service.

1.2 Product Overview

The Guardian 6100 Plus Safety Analyzer combines six critical safety tests into a single instrument, these being **AC hipot, DC hipot, insulation resistance, leakage current, ground bond and Open/Short detection.** The hipot test can be programmed over a voltage range of 0.05 to 5kV AC and 0.05 to 6kV DC with a min/max leakage current detection range of 1µA to 40mA AC and 0.1µA to 12mA DC. Insulation resistance measurements are possible to 50GΩ at programmable DC test voltages between 50 and 1000V. Leakage current measurement is possible for five human body simulation circuits per UL544NP, UL544P, UL1563, UL2601-1, IEC601-1 and UL-1950 test standards. The 6100 Plus Safety Analyzer comes standard with the built-in 6000-07 Hipot/Leakage Current Scanner. The 6000-07 scanner has 20A input current capability. Ground bond testing to 30A AC (40A with optional transformer) is also possible. The G6100 Plus is the industry's first safety analyzer with revolutionary Twin-Port™ technology for **simultaneous** hipot and ground bond testing. In automated environments, dramatic time savings can be achieved and product throughput increased by performing Ground Bond and Hipot at the same time.

The Open/Short Circuit (OSC) detection mode verifies the proper connection of the DUT by comparing the test reading to a standard capacitance value, Cs. OSC voltage is less than 100V and frequency is 600Hz. The instrument comes standard with internal storage of 100 test setups with 50 steps each; RS-232 and Remote I/O interfaces for remote control operation and communication with other instrumentation and a scanner interface for multi-point testing. Scanner options include the 5000 Series external scanners. Optional IEEE-488 or Printer interfaces are also available. Selecting Floating Ground for a test circuit is possible via connection to the rear panel output and programming channel 3 high or low.

WARNING

The Guardian 6100 Plus Electrical Safety Analyzer is capable of generating extremely HIGH VOLTAGE up to 6000VDC.

Do NOT touch the Test Terminals when the red DANGER LED is ON.

Always make sure the DANGER LED is OFF when connecting or disconnecting the device under test (DUT).

1.3 Controls and Indicators

1.3.1 Front Panel Controls and Indicators

Figure 1-1 illustrates the controls and indicators on the front panel of the Guardian 6100 Plus. Figure 1-2 is a detailed illustration of the key pad (5 of Figure 1-1). Table 1-1 identifies the controls and indicators with descriptions and functions.

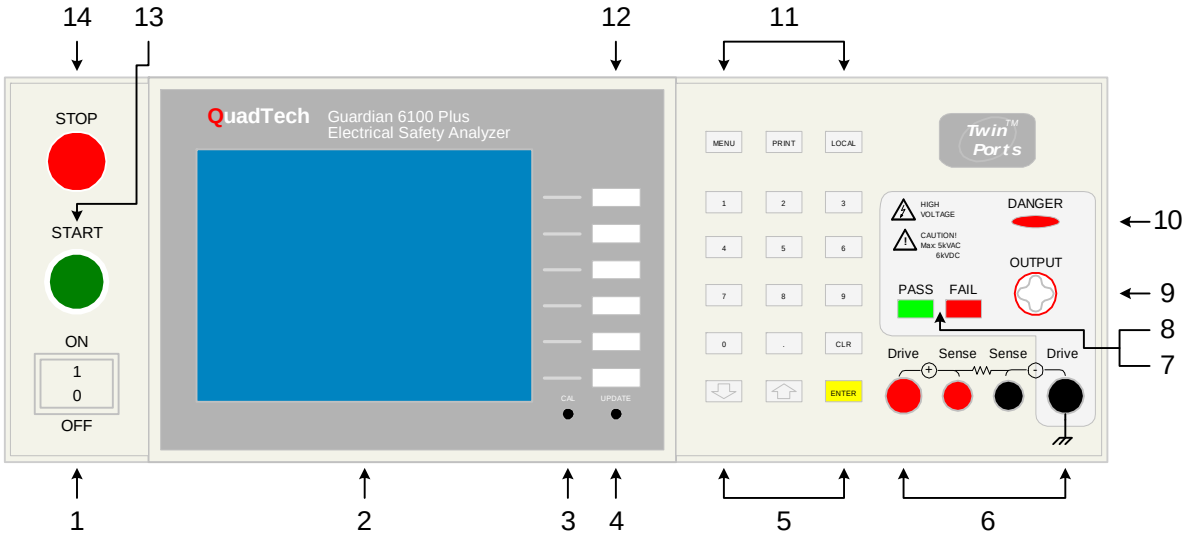


Figure 1-1: G6100 Plus Front Panel Controls & Indicators

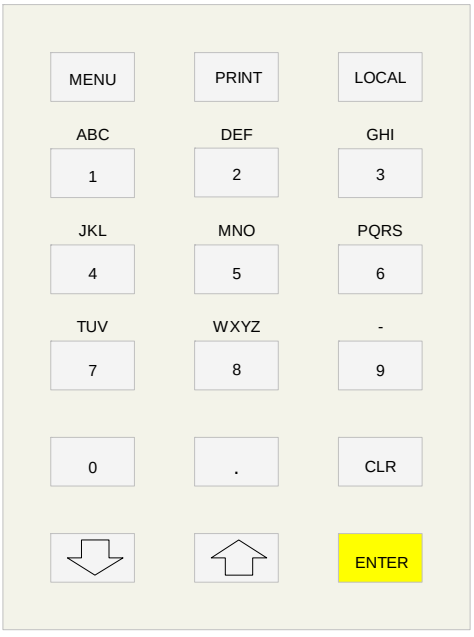


Figure 1-2: Close-Up G6100 Plus Key Pad

Table 1-1 : G6100 Plus Front Panel Controls and Indicators

Reference Number Figures 1-1 and 1-2	**Name**	**Type**	**Function**
1	POWER	White Toggle Switch	Applies AC power to unit, 0=OFF, 1=ON
2	Display	320x240 LCD	Indicates step, mode, limits, test setup, test result
3	Cal Enable	Recessed switch	Used by Qualified Service Personnel for unit calibration.
4	Update	Recessed switch	Used by Qualified QT Personnel for unit service.
5	Keypad	White Push Buttons	Enter data to program tests
	1, ABC	White Push Button	Alpha-numeric key: 1-A-B-C-a-b-c
	2, DEF	White Push Button	Alpha-numeric key: 2-D-E-F-d-e-f
	3, GHI	White Push Button	Alpha-numeric key: 3-G-H-I-g-h-i
	4, JKL	White Push Button	Alpha-numeric key: 4-J-K-l-j-k-l
	5, MNO	White Push Button	Alpha-numeric key: 5-M-N-O-m-n-o
	6, PQRS	White Push Button	Alpha-numeric key: 6-P-Q-R-S-p-q-r-s
	7, TUV	White Push Button	Alpha-numeric key: 7-T-U-V-t-u-v
	8, WXYZ	White Push Button	Alpha-numeric key: 8-W-X-Y-Z-w-x-y-z
	9, -	White Push Button	Alpha-numeric key: 9, - (hyphen)
	0	White Push Button	Numeric key: 0
	.	White Push Button	Decimal key
	CLR	White Push Button	To cancel parameter number and input again
	↓	White Push Button	To move down a menu
	↑	White Push Button	To move up a menu
	ENTER	Yellow Push Button	To enter test parameters
6a	Drive+	Red Female Recptacle	High Current Terminal (Driver) for Ground Bond Test
6b	Sense+	Red Female Recptacle	High Voltage Terminal (Sense) for Ground Bond Test
6c	Sense-	Black Female Recptacle	Low Voltage Terminal (Sense) for Ground Bond Test
6d	Drive-	Black Female Receptacle	Ground Reference for ALL Tests
7	PASS	Green LED	When lit, indicates PASS result of programmed test
8	FAIL	Red LED	When lit, indicates FAIL result of programmed test
9	OUTPUT	White Female Receptacle	High Voltage Terminal (AC/DC Hipot & IR)
10	DANGER	Red LED	When lit, indicates high voltage output at test terminals
11a	MENU	White Push Button	Main Menu & Sub-menus, Program, Memory, Preset, Test
11b	PRINT	White Push Button	When Printer interface is installed and PRINT is pressed: In PROGRAM mode: print out test parameters In TEST mode: print out test results
11c	LOCAL	White Push Button	In REMOTE status, pressing LOCAL returns G6100Plus to LOCAL mode
12	Function Keys	White Push Button	Select Sub-menus and enter test parameters
13	START	Green Push Button	Starts a test and applies high voltage to the Test Terminals
14	STOP	Red Push Button	Stops the test in progress. Reset function : Stop MUST be pressed before green Test button.

1.3.2 Rear Panel Controls and Indicators

Figure 1-3 illustrates the controls and indicators on the rear panel of the Guardian 6100 Plus. Figure 1-4 is a detailed illustration of the two remote connsctors on the rear panel of the Guardian 6100 Plus. Table 1-2 identifies them with description and function.

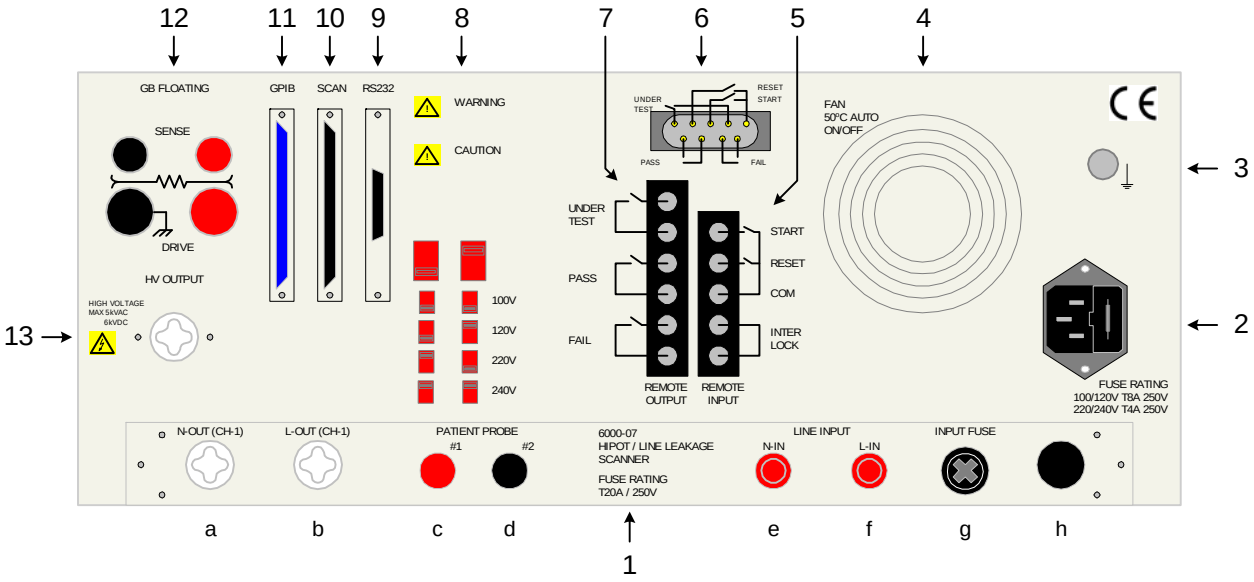


Figure 1-3: G6100 Plus Rear Panel Controls and Connectors

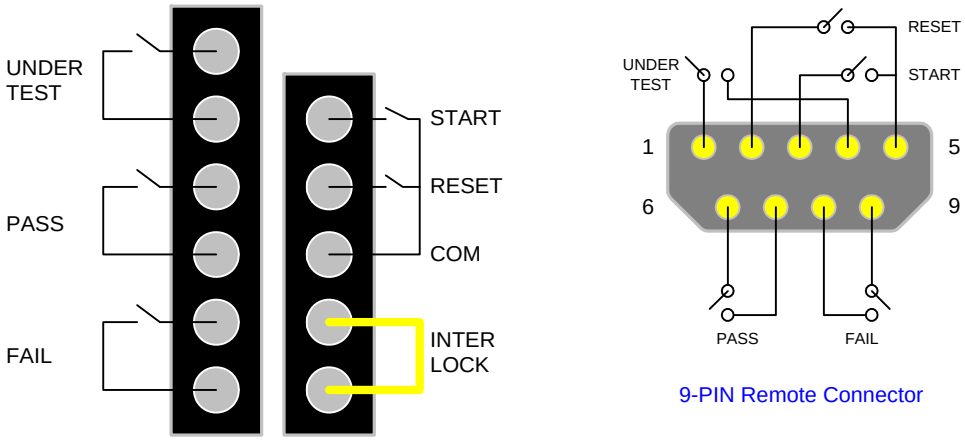


Figure 1-4: Detail G6100 Plus Remote Connectors

Table 1-2: G6100 Plus Rear Panel Connectors and Controls

Reference Number Figure 1-3	Name	Type	Function
1	6000-07	Internal Scanner	Hipot/Line Leakage Current Scanner
a	N-OUT CH-1	White Banana Plug	Neutral Output to DUT
b	L-OUT CH-1	White Banana Plug	Line Output to DUT
c	#1	Red Banana Plug	Patient Probe #1
d	#2	Black Banana Plug	Patient Probe #2
e	N-IN	Red Banana Plug	Neutral Input (from isolation transformer)
f	L-IN	Red Banana Plug	Line Input (from isolation transformer)
g	INPUT FUSE	Black screw cap	T20A 250V SB
h	Fan	MW-2510M12C, 0.11A12V	Cool scan unit
2	AC Inlet Module	Black 3-prong receptacle and fuse drawer	3-wire connection for AC power source. Fuse drawer: 8A 250V for 100-120 operation, 4A 250V for 220-240 operation.
3	GROUND	Silver Banana Jack/Screw	Chassis ground connection
4	FAN	Fulltech UF80A12 AC120V 50/60Hz, 14/12 W	Temperature Control Fan to cool unit: ON ≥50°C, OFF <50°C
5	REMOTE INPUT	Black 5 screw relay strip	Remote input signals : START, RESET, COM & INTER LOCK
6	REMOTE	Silver 9 pin D-Type Connector	Input signals : START & RESET Output signals : UNDER TEST, PASS & FAIL
7	REMOTE OUTPUT	Black 6 screw relay strip	Remote output signals : UNDER TEST, PASS, & FAIL
8	Voltage Selector	Red 2-position DIP Switches (2)	Switches for selecting range of AC power source: Set to 100V for 90-110VAC operation Set to 120V for 108-132VAC operation Set to 220V for 198-242VAC operation Set to 240V for 216-250 VAC operation
9	RS232	Black 9 pin D-Type Female Connector	Serial Input/Output connections for RS232 Interface
10	SCAN	Black 25 pin D-Type Female Connector	Input/Output connection for EXT Scanner Interface
11	GPIB	Blue 24 pin connector	Parallel I/O connections for IEEE-488 (Optional) or Printer (Optional)
12	DRIVE +	Red Banana Jack/Screw	Rear Panel Output High Current GB Test
12	SENSE +	Red Banana Jack/Screw	Rear Panel Output High Voltage GB Test
12	SENSE -	Black Banana Jack/Screw	Rear Panel Output Low Voltage GB Test
12	DRIVE -	Black Banana Jack/Screw	Rear Panel Output Ground Ref. for all Tests
13	HV OUTPUT	White Female Receptacle	Rear Panel Output Channel 3; Program High or Low

1.4 Installation

1.4.1 Dimensions

The Guardian 6100 Plus instrument is supplied in bench configuration (a cabinet with resilient feet for placement on a table). Flip feet are provided under the front feet so that the unit can be tilted back for convenient operator viewing. An optional rack mount kit is available.

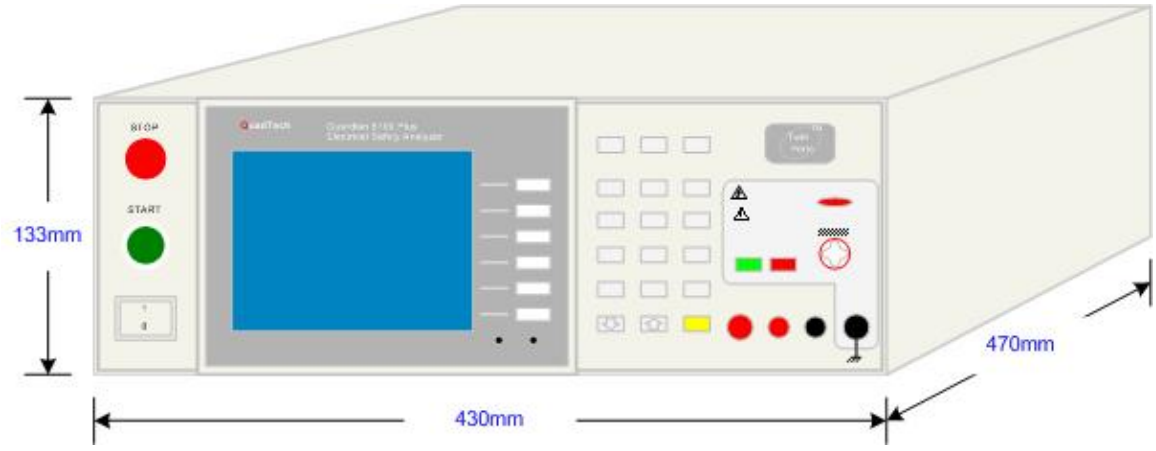


Figure 1-5: G6100 Plus Instrument Dimensions

1.4.2 Instrument Positioning

The Guardian 6100 Plus Safety Analyzer contains a digital 320x240 LCD display for direct readout of the measured parameters. The optimum viewing angle is slightly down and about 10° either side of center. For bench operation the front flip feet should always be used to angle the instrument up. In bench or rack mount applications the instrument should be positioned with consideration for ample air flow around the rear panel fan ventillation hole. An open space of at least 75mm is recommended behind the rear panel.

1.4.3 Power Requirements

The Guardian 6100 Plus can be operated from a power source of 90 to 130 VAC or 200 to 250 VAC. Power connection is via the rear panel through a standard receptacle. Before connecting the 3-wire power cord between the unit and AC power source make sure the voltage selection switches on the rear panel (Figure 1-6) and fuses are in accordance with the power source being used. 8A, 250V, 5x20mm, for 90-130V source and 4A, 250V, 5x20mm, for 200-250V source. Always use an outlet which has a properly connected protection ground.

Procedure for Changing A Guardian 6100 Plus Fuse

WARNING
MAKE SURE THE UNIT HAS BEEN DISCONNECTED FROM ITS AC POWER SOURCE FOR AT LEAST 5 MINUTES BEFORE PROCEEDING.

Remove the fuse drawer, by inserting a flat head screwdriver behind the small tab located just below the 3 prong receptacle, and force outward.

Once the fuse drawer has been removed from the instrument snap the fuse from the holder and replace. Make sure the new fuse is of the proper rating. Note that the fuse drawer can also be used to store a spare fuse.

Install the fuse drawer back in the inlet module (fuse down) by pushing in until it locks securely in place.

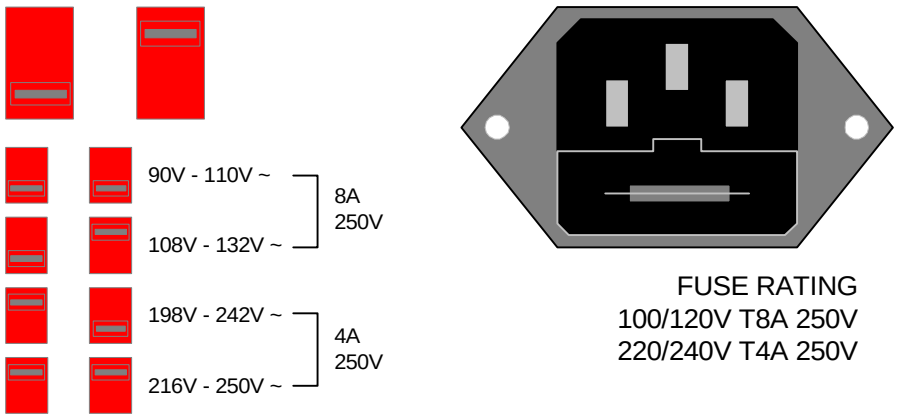


Figure 1-6: AC Inlet Module & Voltage Selector Switches

1.4.4 Safety Inspection

⚠ Before operating the instrument inspect the power inlet module on the rear of the Guardian 6100 Plus to ensure that **the properly rated fuse is in place**, otherwise damage to the unit is possible. Refer to paragraph 1.4.3.

The Guardian 6100 Plus is shipped from QuadTech with a standard U.S. power cord, QuadTech P/N 4200-0300 (with Belden SPH-386 socket or equivalent and 3-wire plug conforming to IEC 320). Make sure that the instrument is used only with these cables (or approved international cord set) to ensure that the instrument is provided with **connection to protective earth ground.**

The surrounding environment should be free from excessive dust to prevent contamination of electronic circuits. The surrounding environment should also be free from excessive vibration. Do not expose the Guardian 6100 Plus unit to direct sunlight, extreme temperature or humidity variations, or corrosive chemicals.

Section 2 : Operation

2.1 Terms and Conventions

Table 2-1 : Measurement Unit Prefixes

Multiple	Scientific	Engineering	Symbol
1000000000000000	10^{15}	Peta	P
1000000000000	10^{12}	Tera	T
1000000000	10^{9}	Giga	G
1000000	10^{6}	Mega	M
1000	10^{3}	Kilo	k
.001	10^{-3}	milli	m
.000001	10^{-6}	micro	u
.000000001	10^{-9}	nano	n
.000000000001	10^{-12}	pico	p
.000000000000001	10^{-15}	femto	f

ARCing: Sparking or 'flashing over' caused by a breakdown of electrical insulation.

Charging Current: An insulated product exhibits the basic characteristics of a capacitor. Application of a voltage across the insulation causes a current to flow as the capacitor charges. This current instantaneously rises to a high value as voltage is applied then exponentially decays to zero as the DUT becomes fully charged. Charging current decays to zero much faster than dielectric absorption.

Dielectric Strength: The ratio between the voltage at which breakdown of the insulating material occurs and the distance between the two points subject to the applied voltage.

Dielectric Absorption: The physical phenomenon in which insulation appears to absorb and retain an electrical charge slowly over time. Apply a voltage to a capacitor for an extended period of time, then quickly discharge it to zero voltage. Leave the capacitor open circuited for a period of time then connect a voltmeter to it and measure the residual voltage. The residual voltage is caused by the dielectric absorption of the capacitor.

Discharge: The act of draining off an electrical charge to ground. Devices that retain charge should be discharged after an IR or DC HiPot test.

Frequency: The rate at which current or voltage reverses polarity and then back again completing a full cycle, measured in Hertz (Hz) or cycles/second. AC Line Frequency =50/60 Hz.

Ground: The base reference from which voltages are measured, nominally the same potential as the earth. Also the side of a circuit that is at the same potential as the base reference.

Ground Continuity Test: Test to verify that all conductive parts of a product that are exposed to user contact are connected to the power line ground. GC Test normally performed with a low current DC signal that checks to ensure the ground connection has a resistance of <1Ω.

Ground Bond Test: Test to verify that all conductive parts of a product that are exposed to user contact are connected to the power line ground. The ground bond test is similar to the ground continuity test. The main difference is that the ground bond test verifies the integrity of the ground connection using a high current AC signal with current level as high as 30Amps. Ground bond provides a better simulation of how a product will perform under an actual fault condition.

Insulation Resistance: Measures the total resistance between any two points separated by electrical insulation. The IR test determines how effective the dielectric (insulation) is in resisting the flow of electrical current.

Interface:

- IEEE-488: General Purpose Interface Bus (GPIB). An industry standard definition of a Parallel bus connection for the purpose of communicating data between devices.
- RS232: An industry standard definition for a Serial line communication link or port.
- Scanner: A electronic device designed to switch or matrix signals.

Leakage Current (LC):

Leakage Current:	The residual flow of current that flows through the insulation after a high voltage has been applied for a period of time. The leakage current is equal to the applied voltage divided by the insulation resistance. Leakage current is the main measured value for AC hipot and DC hipot.
Applied Part LC Test:	A line leakage current test which measures the current that would flow from, to or between applied parts such as sensor and patient leads. This test is the most complicated and time consuming line leakage test.
Earth LC:	The leakage current from all earthed parts of the product. The current flowing from the mains supply through or across insulation into the protective earth (PE) conductor.
Enclosure LC:	Leakage from the enclosure or other parts, excluding applied parts that are not connected to a protective earth (PE) conductor. Also known as “Touch Chassis” Leakage
Patient LC:	The current flowing from every individual part of the applied part back to earth or the current flowing from an unintended appearance of a voltage on the patient back to a F-Type Applied Part.
Patient Auxiliary LC:	Current flowing between patient connections and that is not intended to be there to produce an effect in the patient.

Limit

High Limit:	The high limit is the upper value for a test to be considered a pass. If the measured value is higher than the high limit the test is considered a fail. In hipot, leakage current and ground bond modes a high limit is required.
Low Limit:	The low limit is the lower value for a test to be considered a pass. If the measured value is lower than the low limit the test is considered a fail. This limit is typically used for AC hipot to ensure the DUT is connected. In insulation resistance mode a low limit is required.

Mode: The test which is to be performed such as AC Hipot (AC), DC Hipot (DC), Insulation Resistance (IR), Leakage Current (LC), Ground Bond (GB) or Open/Short Circuit (OSC).

RAMPing: The gradual increase or decrease of voltage or current over a period of time (step).

Step: The Guardian 6100 Plus can perform up to 50 tests in a sequence. The step number indicates in which order the tests will be performed. For example if step 1 is a ground bond test, step 2 an AC hipot and step 3 an insulation resistance measurement then when a test is started the G6100 Plus will perform a ground bond test followed by an AC hipot then an insulation resistance measurement.

Test Time:

- Ramp: The period of time for the voltage to climb to the programmed level.
- Dwell: The period of time for the voltage to settle at the programmed level. (a.k.a.: delay)
- Test: The period of time that the voltage is applied to the DUT.
- Fall: The period of time for the voltage to decrease back to 0.

Twin Port™: Exclusive feature of Guardian 6100 Plus. Twin Port™ allows for optimum speed performance by combining the Ground Bond test with the Hipot test (AC or DC) so that they run at the same time.

2.2 Startup

Check to make sure the Red Voltage Selector Switches on the rear panel agree with the power source available. Depending on the power source the switch positions should be in the up or down positions as shown in Figure 1-6 (AC Inlet Module & Voltage Selector Switches).

WARNING
NEVER TOUCH THE TEST LEADS IN ANY MANNER (this includes insulation on all wires and clips) when the HIGH VOLTAGE IS APPLIED and red DANGER LED is ON.

USE ALL PRECAUTIONS NECESSARY TO AVOID TOUCHING THE DEVICE UNDER TEST WHEN THE RED DANGER LED IS ON OR FLASHING.

Connect the instrument power cord to the source of proper voltage. **The instrument is to be used only with three wire grounded outlets.**

Power is applied to the G6100 Plus by pressing the white [POWER] toggle switch on the front panel to ON (1 position). The G6100 Plus unit should have a warm-up time of at least 15 minutes prior to use.

WARNING
DO NOT TURN INSTRUMENT POWER ON OR OFF WITH TEST DEVICES CONNECTED.

Note: Read the entire manual before operating the Guardian 6100 Plus instrument.

2.3 MAIN MENU

When powered ON, the G6100 instrument will boot to the MAIN MENU display. At any time, press [MENU] to return to the MAIN MENU display. Within the MAIN MENU there are 7 vertical sub-menus: System, Option, Calibration, Key Lock, New Security Code, Fail Lock and Error Log. To access any of these 7 vertical sub-menus, press the numerical key that corressponds to the menu. There are 4 functional menus on the right side of the MAIN MENU display: Memory, Preset, Program and Test. To access any of these 4 sidebar menus, press the function key to the right of the display that corresponds to the sidebar menu. Refer to Figure 2-1.

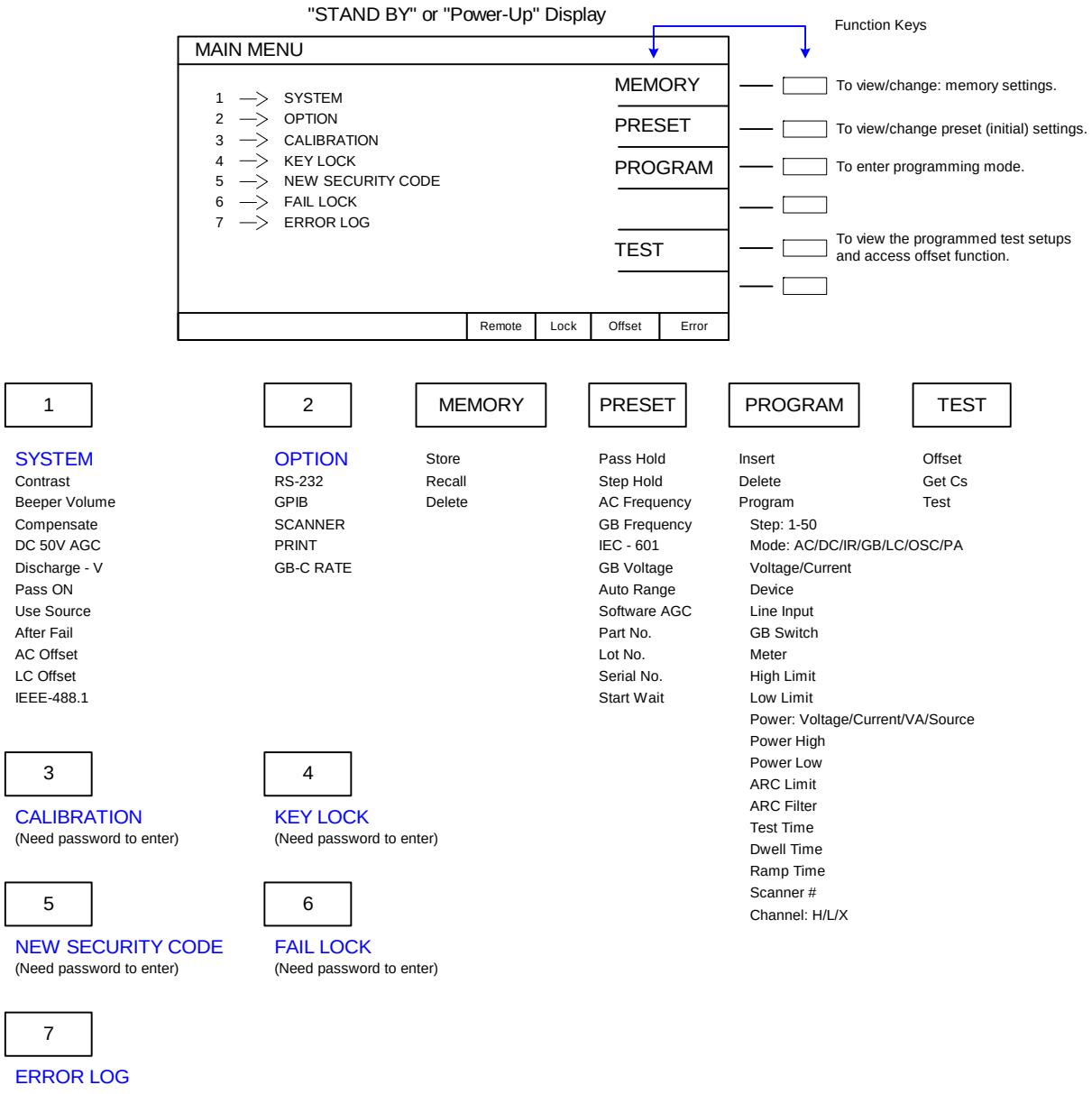


Figure 2-1: MAIN MENU

2.3.1 SYSTEM

To access SYSTEM SETUP, press the [MENU] function key at the top left hand corner of the keypad and press the numerical key [1]. Within SYSTEM SETUP there are 11 parameters: Contrast, Beeper Volume, Compensate, DC 50V AGC, Discharge Voltage, Pass ON, Use Source, After Fail, AC Offset, LC Offset and IEEE-488.1. Refer to Figure 2-2.

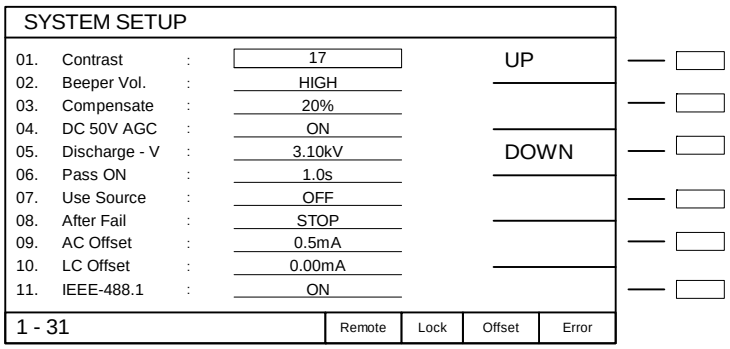


Figure 2-2: SYSTEM SETUP

To access any of these 11 parameters, press the [↑] or [↓] arrow on the keypad to move the backlit box to the desired parameter. The status window in the bottom left-hand corner of the display shows the range for the selected parameter. Use the function keys or the numerical keys and [ENTER] to set a SYSTEM parameter.

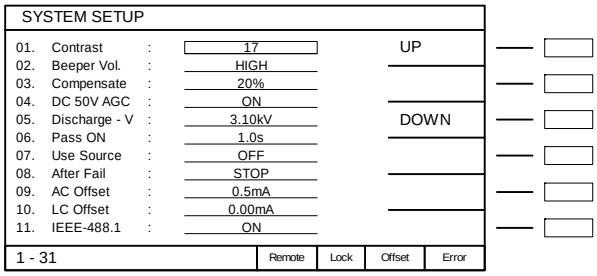
Table 2-2: System Parameters

Parameter	Range	Default
Contrast	1-31	17
Beeper Volume	HIGH, MEDIUM, LOW, OFF	HIGH
Compensate	±(5-50%) or OFF	20%
DC 50V AGC	ON/OFF	ON
Discharge-V	0.05 – 5.1kV	5.1kV
PASS On	0.1 – 99.9s, CONT	CONT
Use Source	ON/OFF	OFF
After Fail	CONTINUE, STOP, START	STOP
AC Offset	0 – 2.5mA	0.50mA
LC Offset	0 – 2.5mA	0.00mA
IEEE-488.1	ON/OFF	OFF

NOTE:
The G6100 Plus can be used with an AC Source (¶2.3.1.7). In the SYSTEM menu, select USE SOURCE = ON so that in LC Mode the POWER option SOURCE is operational. Set POWER = Source; TARGET-V in the range 80-300V and TARGET-F = 50 or 60Hz.

2.3.1.1 Contrast

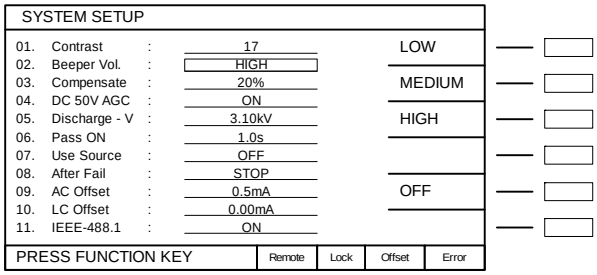
To access Contrast, press [MENU], [1] and the [↓] or [↑] arrow on the keypad so the backlit box is to the right of Contrast. Use the function keys [UP] or [DOWN] to increase or decrease the contrast. The display Contrast is adjustable from 1 – 31. A value of 1 is brightest , a value of 31 is darkest. The default setting for Contrast is 17.



2.3.1.2 Beeper Volume

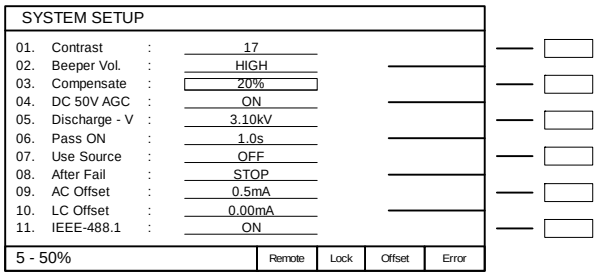
To access Beeper Volume, enter System Setup by pressing [MENU], [1] and the [↓] or [↑] arrow on the keypad so the backlit box is to the right of Beeper Volume. Use the function keys [LOW], [MEDIUM], [HIGH] or [OFF] to increase or decrease the volume. The Beeper Volume can be set to OFF or to sound in a High, Medium or Low tone. The default setting for Beeper Volume is HIGH.

The beeper will sound each time a button is pushed. It will beep at the end of a test and will sound continuously until the [STOP] button is pressed when a fialure occurs. If an arc occurs, the beeper will beep (although not a continuous alarm).



2.3.1.3 Compensate

This setting is valid for Guardian 6100 Plus line leakage test only. Compensate is the LC input voltage compensation in which a correction (% value) can be added to better simulate what the true line leakage would be. The simulation correction value can be programmed in whole number increments of ±(5-50%). Use the numerical keys then [ENTER] to enter a compensate value in percent. The range is 5-50% and the default setting is 20%.



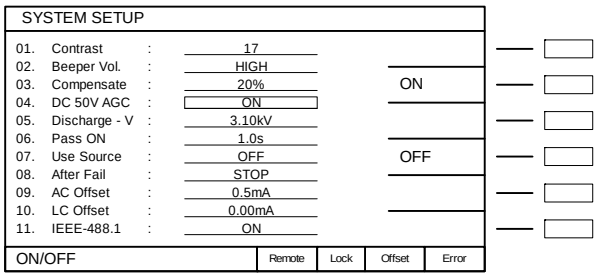
2.3.1.4 DC 50V AGC

The Automatic Gain Control (AGC) circuit is used to keep the output signal of a circuit constant as the amplitude of the input signal varies. The Guardian 6000 Plus has two Gain Control circuits: hardware and software. See Table 2-3 for gain control functions based on output voltage.

Table 2-3: AGC & Output Voltage

Output	Hardware AGC	Software AGC	DC 50 V AGC
50 – 5kV AC	ON	Programmable (Default ON)	NA
50 – 499V DC	OFF	Programmable (Default ON)	Programmable (Default OFF)
500 – 6kV DC	ON	Programmable (Default ON)	NA
50 – 1000V DC (IR)	None	Always On	NA

DC 50V AGC is the hardware gain control for DC voltages below 500V. To access DC 50V AGC, enter System Setup by pressing [MENU], [1] and the [↓] or [↑] arrow on the keypad so the backlit box is to the right of DC 50V AGC. Use the function key [ON] or [OFF] to turn the automatic gain control circuit ON or OFF. The default setting is OFF.



2.3.1.5 Discharge-V

The Discharge-V function lets the user set the voltage that the G6100 Plus instrument will discharge to upon completion of a hipot test. The time it will take to discharge to a specific voltage is dependent on the capacitance of the DUT. The discharge time is a natural log function. To access Discharge-V, enter System Setup by pressing [MENU], [1] and the [↓] or [↑] arrow on the keypad so the backlit box is to the right of Discharge-V. Use the numerical keys then [ENTER] to enter a voltage value in kV. The range is 0.05kV to 5.10kV and the instrument default value is 5.10kV.

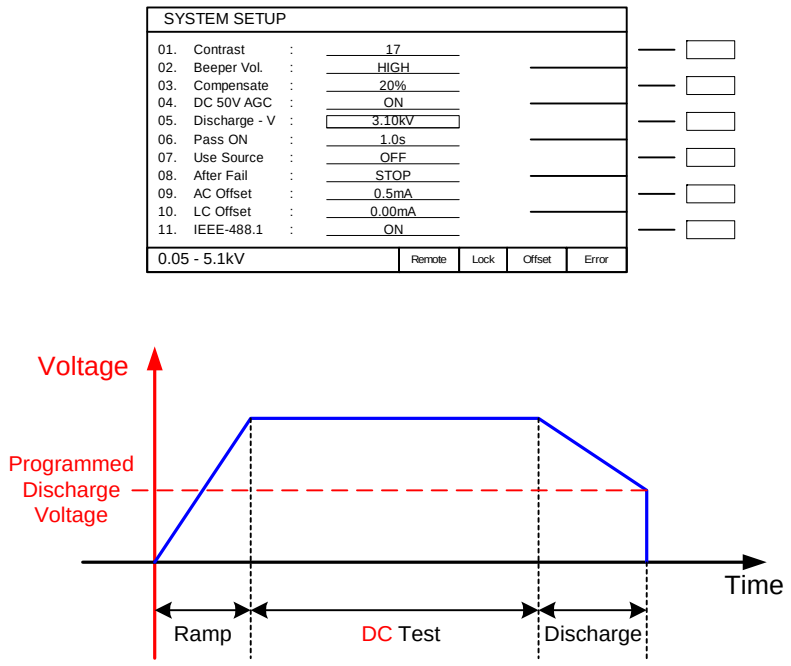
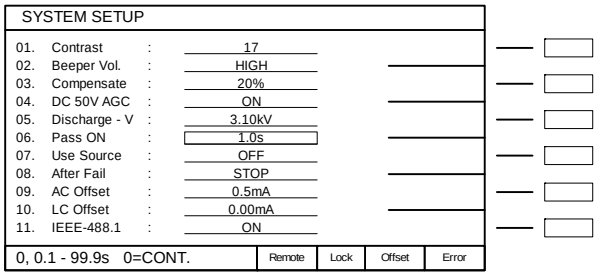


Figure 2-3: Discharge Voltage

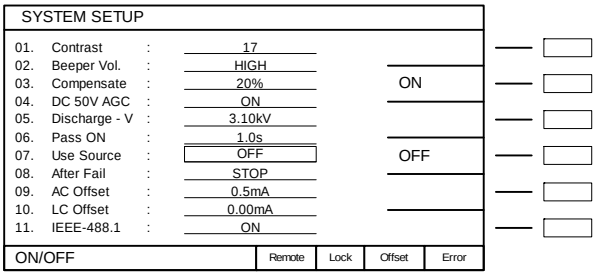
2.3.1.6 Pass ON

The PASS ON setting provides the option of programming a pass relay closed time after a PASS condition at the completion of the test. When set to CONT, the relay opens at start of next test or when unit is reset. To access Pass-ON, enter System Setup by pressing [MENU], [1] and the [↓] or [↑] arrow on the keypad so the backlit box is to the right of Pass-ON. Use the numerical keys then [ENTER] to enter the time in seconds. The range for PASS ON is 0.1 – 99.9sec or CONT (continuous) and the instrument default value is CONT. The beeper will also sound for the duration of the Pass ON time to indicate the test is complete.

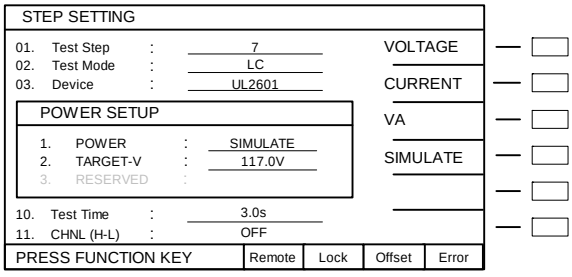


2.3.1.7 Use Source

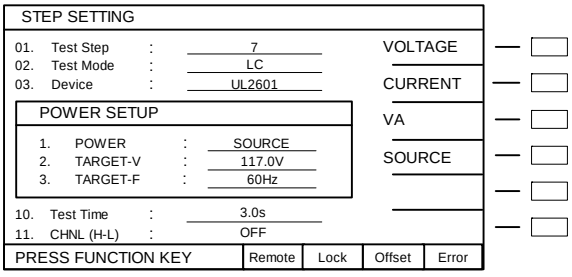
This function is valid for the Guardian 6100 Plus line leakage test only. The Use Source function is used when the G6100 Plus instrument is connected to a Chroma 6400 Series AC Power Source. It is valid in simulated leakage current mode only and requires an RS-232 connection to the 6400. The source is set ON or OFF. The default setting is OFF.



LC Mode with USE SOURCE = OFF



LC Mode with USE SOURCE = ON



NOTE:
The G6100 Plus can be used with an AC Source (¶2.3.1.7). In the SYSTEM menu, select USE SOURCE = ON so that in LC Mode the POWER option SOURCE is operational. Set POWER = Source; TARGET-V in the range 80-300V and TARGET-F = 50 or 60Hz.

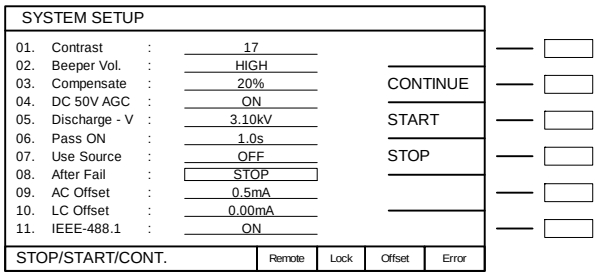
2.3.1.8 After Fail

The After Fail function lets the programmer instruct the G6100 Plus how to proceed when a test result is a FAIL. To access After Fail, enter System Setup by pressing [MENU], [1] and the [↓] or [↑] arrow on the keypad so the backlit box is to the right of After Fail. Use the function keys [CONTINUE], [STOP] or [START] to instruct the instrument to continue on fail, stop on fail or re-start on fail.

When "Continue on Fail" is selected, the Guardian 6100 Plus will continue to run any remaining steps that are programmed after the step in which the Fail occurred. The Guardian 6100 Plus will then indicate a failure at the end of the test.

Selecting "Start on Fail" is useful for automated systems. Typically when a failure occurs, the instrument requires a STOP signal to be sent (or the [STOP] button pressed). Selecting "Start on Fail" deactivates the requirement to send a stop signal.

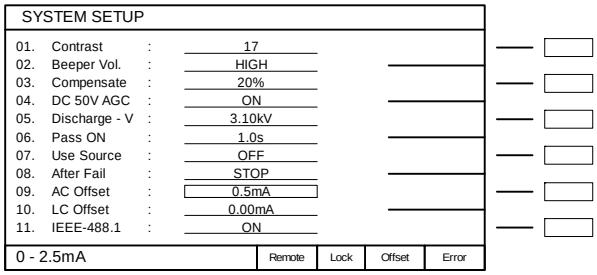
The default setting is "Stop on Fail". When a failure occurs, the Guardian 6100 Plus instrument will stop at the time of failure. A STOP signal is required to begin testing again.



2.3.1.9 AC Offset

The AC Offset function determines how the AC offset value will be applied to the displayed current reading. If the measured offset value is higher than the programmed AC Offset value then the Displayed Current = (Measured value) – (Offset value). If the measured offset is lower than the AC offset value then the Displayed Current = the square root of (Measured value)^2 – (Offset value)^2.

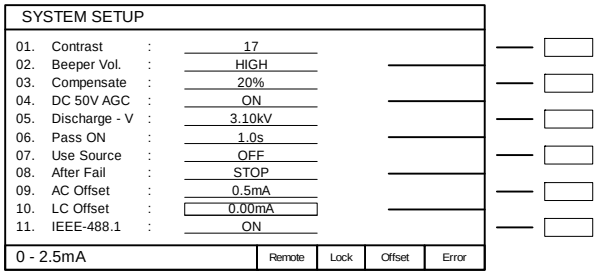
To access AC Offset, enter System Setup by pressing [MENU], [1] and the [↓] or [↑] arrow on the keypad so the backlit box is to the right of AC Offset. Use the numerical keys then [ENTER] to enter the current in mA. The range for AC Offset is 0 – 2.5mA and the default value is 0.5mA.



2.3.1.10 LC Offset

This function is valid for the Guardian 6100 Plus line leakage test only. If the measured offset value is higher than the programmed LC Offset value then the Displayed Current = (Measured value) – (Offset value). If the measured offset is lower than the LC offset value then the Displayed Current = the square root of (Measured value)^2 – (Offset value)^2.

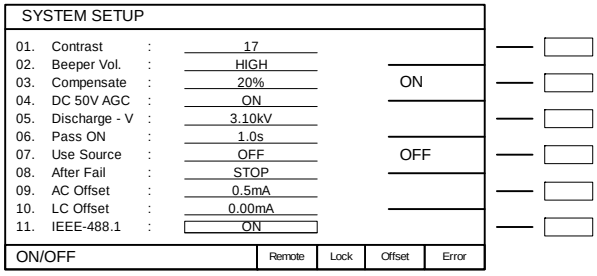
To access LC Offset, enter System Setup by pressing [MENU], [1] and the [↓] or [↑] arrow on the keypad so the backlit box is to the right of LC Offset. Use the numerical keys then [ENTER] to enter the current in mA. The range for LC Offset is 0 – 2.5mA and the default value is 0.0mA.



2.3.1.11 IEEE-488.1

Select IEEE-488.1 to ON to make the remote commands compatible with the QuadTech Guardian 6000 instrument. When IEEE-488.1 is set to ON, only the Guardian 6000 commands are valid. Refer to the Guardian 6000 instruction manual (P/N 150354) for a set of commands.

To access IEEE-488.1, enter System Setup by pressing [MENU], [1] and the [↓] or [↑] arrow on the keypad so the backlit box is to the right of IEEE-488.1. Use the function key [ON] or [OFF] to turn the interface ON or OFF. The default setting is OFF.



2.3.2 OPTION

To access the OPTION MENU, press the [MENU] function key at the top left hand corner of the keypad and press the numerical key [2]. Within OPTION there are 5 parameters: RS-232, GPIB, Scanner, Print and GB-C Rate. To access any of these 5 parameters, use the function keys on the right of the display. Refer to Figure 2-4.

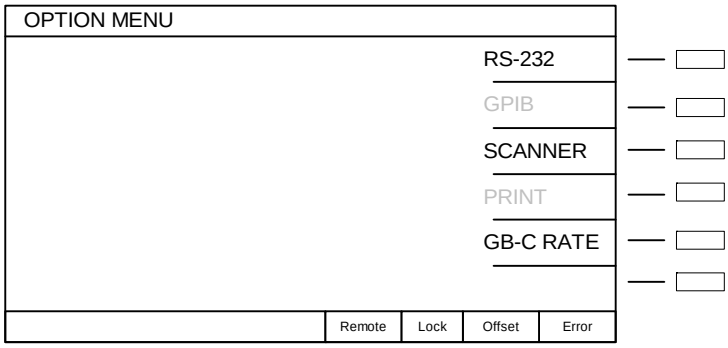
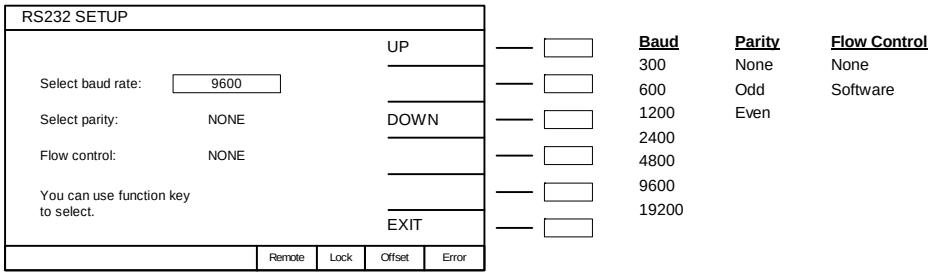


Figure 2-4: Option Menu

Note:
In any of the menus, when the text appears ghost-like "GPIB" with dashed lines it means that optional function is not installed and unavailable.

2.3.2.1 RS-232

Use RS-232 to set the baud rate, parity and flow control for the RS-232 interface. To access RS-232 Setup, enter the Option Menu by pressing [MENU] and [2] then the function key [RS-232]. The backlit box is next to 'Select baud rate'. Use the [UP] or [DOWN] function key to select the baud rate = 300, 600, 1200, 2400, 4800, 9600 or 19200. The default value is 9600 bps.



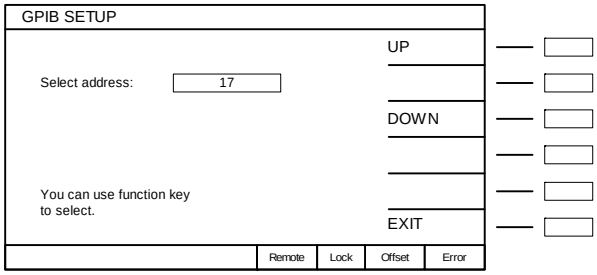
Use the [↓] arrow on the keypad so the backlit box is to the right of 'Select parity'. Use the [UP] or [DOWN] function key to select the parity = ODD, EVEN or NONE. The default value is NONE.

Use the [↓] arrow on the keypad so the backlit box is to the right of 'Flow control'. Use the [UP] or [DOWN] function key to select the parity = NONE or SOFTWARE. The default value is NONE.

Use the [EXIT] key to exit RS232 Setup and return to Option Menu.

2.3.2.2 GPIB

If the optional IEEE interface is installed, use GPIB to set the address for the IEEE interface. To access GPIB, enter the Option Menu by pressing [MENU], [2] and then the function key [GPIB]. The backlit box is next to 'Select address'. Use the [UP] or [DOWN] function keys then [ENTER] to select an address from 1-31. The default is 17.

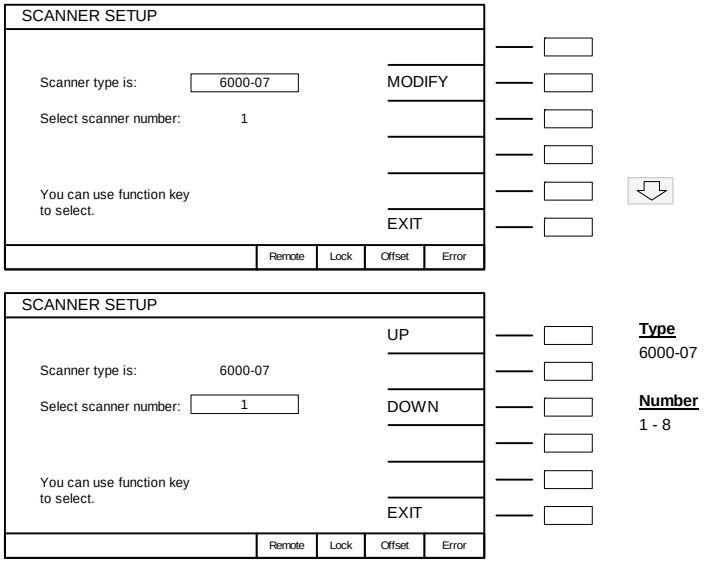


Use the [EXIT] key to exit GPIB Setup and return to Option Menu.

2.3.2.3 Scanner

Use SCANNER to select the type of internal scanner. The G6100 Plus has a 6000-07 internal scanner installed. To access Scanner Setup, enter the Option Menu by pressing [MENU], [2] and then the function key [SCANNER]. The backlit box is next to 'Scanner type is:'. The internal scanner (Scanner 1) is set to 6000-07. Do <u>not</u> modify.

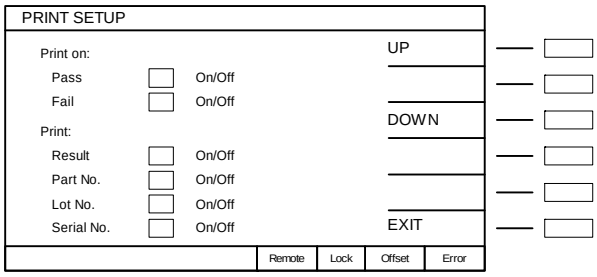
To tell the 6100 Plus unit that there is more than 1 scanner in use, press the [↓] arrow on the keypad so the backlit box is to the right of 'Select Scanner number:'. Use the [UP] or [DOWN] function key then [ENTER] to select the <u>total</u> number of scanners (1-8) in use.



Use the [EXIT] key to exit Scanner Setup and return to Option Menu.

2.3.2.4 Print

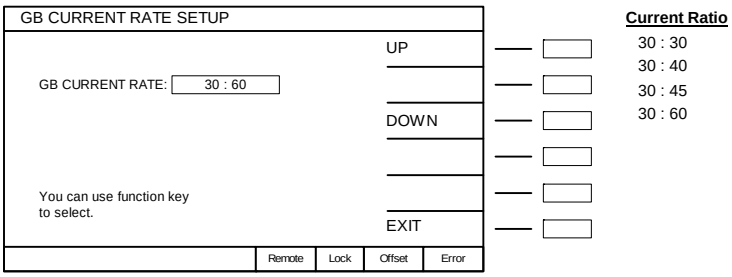
If the optional PRINTER interface is installed, use PRINT to select when and what the Guardian 6100 Plus instrument should print. To access Print Setup, enter the Option menu by pressing [MENU], [2] and then the function key [PRINT]. The backlit box is next to 'Print On'. Use the function keys to select print functions ON/OFF. The default value is OFF. Use the [↑] or [↓] arrow to move backlit box to next print function. Refer to ¶ 3.4 for a sample printout.



Use the [EXIT] key to exit Print Setup and return to Option Menu.

2.3.2.5 GB-C RATE

If an optional High Current transformer is being used, use GB-C RATE to set the current ratio for the Ground Bond test. To access GB-C Rate Setup, enter the Option Menu by pressing [MENU], [2] and then the function key [GB-C RATE]. Use the [UP] or [DOWN] function key to select the current ratio = 30:30, 30:40, 30:45 or 30:60. The default value is 30:30. This ratio must be set prior to programming if using the optional transformer.



Use the [EXIT] key to exit GB-C Rate Setup and return to Option Menu.

2.3.3 CALIBRATION

Refer to Section 4, Sevice & Calibration for the calibration procedure. Calibration of the Guardian 6100 Plus is recommended on an annual basis. The instrument can be calibrated by a qualified service person if traceable calibration equipment and standards are available.

The CALIBRATION function is password protected. To access CALIBRATION, press the [MENU] function key at the top left hand corner of the keypad and press the numerical key [3]. Press [7][9][3][1][ENTER] to enter calibration mode. To protect the accuracy of the instrument, the Calibration Password is different than the User Password.

2.3.4 KEY LOCK

When KEY LOCK is ON, the LOCK status LED on the display is illuminated and the MEMORY and TEST functions are operational. To activate KEY LOCK, press the [MENU] function key at the top left hand corner of the keypad and press the numerical key [4]. Use the numerical keys and press [0][0][0][0][ENTER]. To de-activate KEY LOCK, press [MENU] [4] [0][0][0][0][ENTER]. The LOCK LED will go off and all functions will be operational.

Note: If the Security Code has been changed, [0][0][0][0][ENTER] will not work for KEY LOCK. Use the new Security Code.
When KEY LOCK is ON, the TEST menu will now display RECALL so that memory may easily be recalled. When the G6100 Plus is powered down with KEY LOCK ON, it will boot to the TEST menu when powered back ON.

2.3.5 NEW SECURITY CODE

The NEW SECURITY CODE is the User Password. The initial user password is [6][1][0][0][ENTER]. A password of up to 12 numeric characters may be set. To access NEW SECURITY CODE, press the [MENU] function key at the top left hand corner of the keypad and press the numerical key [5]. Use the numerical keys and press [6][1][0][0][ENTER]. The instrument will prompt for ENTER NEW PASSWORD and CONFIRM NEW PASSWORD.

2.3.6 FAIL LOCK

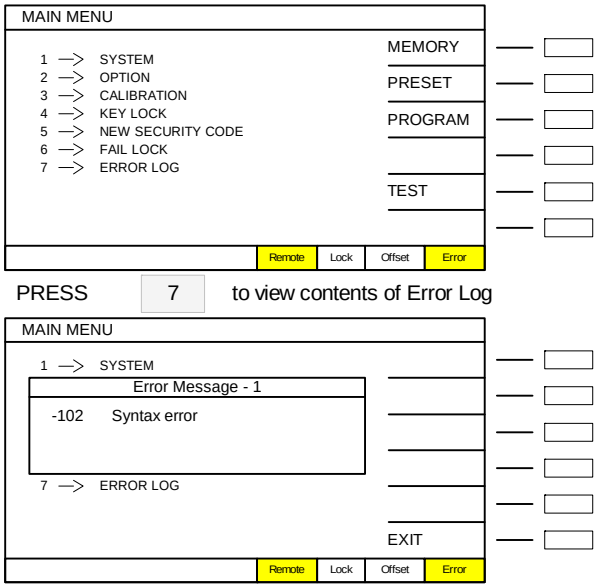
When FAIL LOCK is ON, the LOCK status LED on the display is illuminated and just the TEST function is operational. Use Fail Lock when you want a supervisor to be notified when a failure occurs. Once a failure occurs, no test can be run until the password is entered. When powered is OFF, the Guardian 6100 Plus will boot to the TEST menu when FAIL LOCK is ON. To activate FAIL LOCK, press the [MENU] function key at the top left hand corner of the keypad and press the numerical key [6]. Use the numerical keys and press [6][1][0][0][ENTER]. To de-activate FAIL LOCK, press [MENU] [6] [0][0][0][0][ENTER]. The LOCK LED will go off and all functions will be operational.

Note: If the User Password has been changed, [6][1][0][0][ENTER] will not work for FAIL LOCK. Use the new User Password.

2.3.7 ERROR LOG

The Error Log contains messages that apply to the operation of the instrument with an RS-232 or GPIB (IEEE-488) Interface installed. Refer to Table 2-4 for a list of these error messages. When there is an error in the queue, the ERROR LED in the lower right-hand corner of the display will be illuminated. To access the ERROR LOG, press the [MENU] function key at the top left hand corner of the keypad and press the numerical key [7].

Error messages for the Guardian 6100 Plus instrument are saved in the queue and are accessed by the FIFO method. The first error message is the first saved. When the messages in the queue reach 31, the message in the last position will display “-350, Queue Overflow”.



Reading the messages from the Error Log deletes the error message from the queue.

Table 2-4: Error Messages

Error #	Label	Message Description
+ 0	No error	No error messages in the queue
-102	Syntax error	The command contains an invalid character
-103	Invalid separator	The command contains an invalid separator
-108	Parameter not allowed	Parameter is invalid and cannot be measured
-109	Missing parameter	Test cannot be performed without missing parameter
-112	Program mnemomic too long	The header contains more than 12 characters
-113	Undefined header	Header is unrecognizable
-114	Header suffix out of range	Value of numeric suffix is out of range
-120	Numeric data error	Numerical parameter is invalid
-140	Character data error	Input character is invalid
-151	Invalid string data	Incomplete string of data (i.e. missing double “ ” marks)
-158	String data not allowed	Invalid string of data
-170	Expression error	Incomplete parameter data (i.e. missing right parenthesis)
-200	Execution error	Invalid execute command
-203	Command protected	Invalid command; device does not receive this command
-221	Settings conflict	Device is busy and cannot receive command
-222	Data out of range	Parameter value is out of range
-223	Too much data	Received string is too long, device can’t execute
-291	Out of memory	Main memory is full, data cannot be stored
-292	Referenced name does not exist	Referenced name not found in main memory
-293	Referenced name already exists	Memory already contains a file labeled ‘referenced name’
-350	Queue overflow	More than 30 messages in error queue
-361	Parity error	Program message contains parity error
-363	Time out error	End character not received in time, device timed out
-365	Input buffer over run	Input buffer is out of range

-400	Queue error	Output buffer is out of range
-410	Query Interrupted	No read command following a query command
-420	Query Unterminated	No data in queue and device requested to read queue

2.4 PROGRAM

To access the PROGRAM menu, press [MENU] then press the function key to the right of the display that corresponds to PROGRAM. In the PROGRAM menu, seven modes are programmable including Ground Bond (GB), AC Hipot (AC), DC Hipot (DC), Insulation Resistance (IR), Leakage Current (LC), Pause (PA) and Open/Short Circuit (OSC). Each of these modes has a number of parameters to set as listed in Table 2-5.

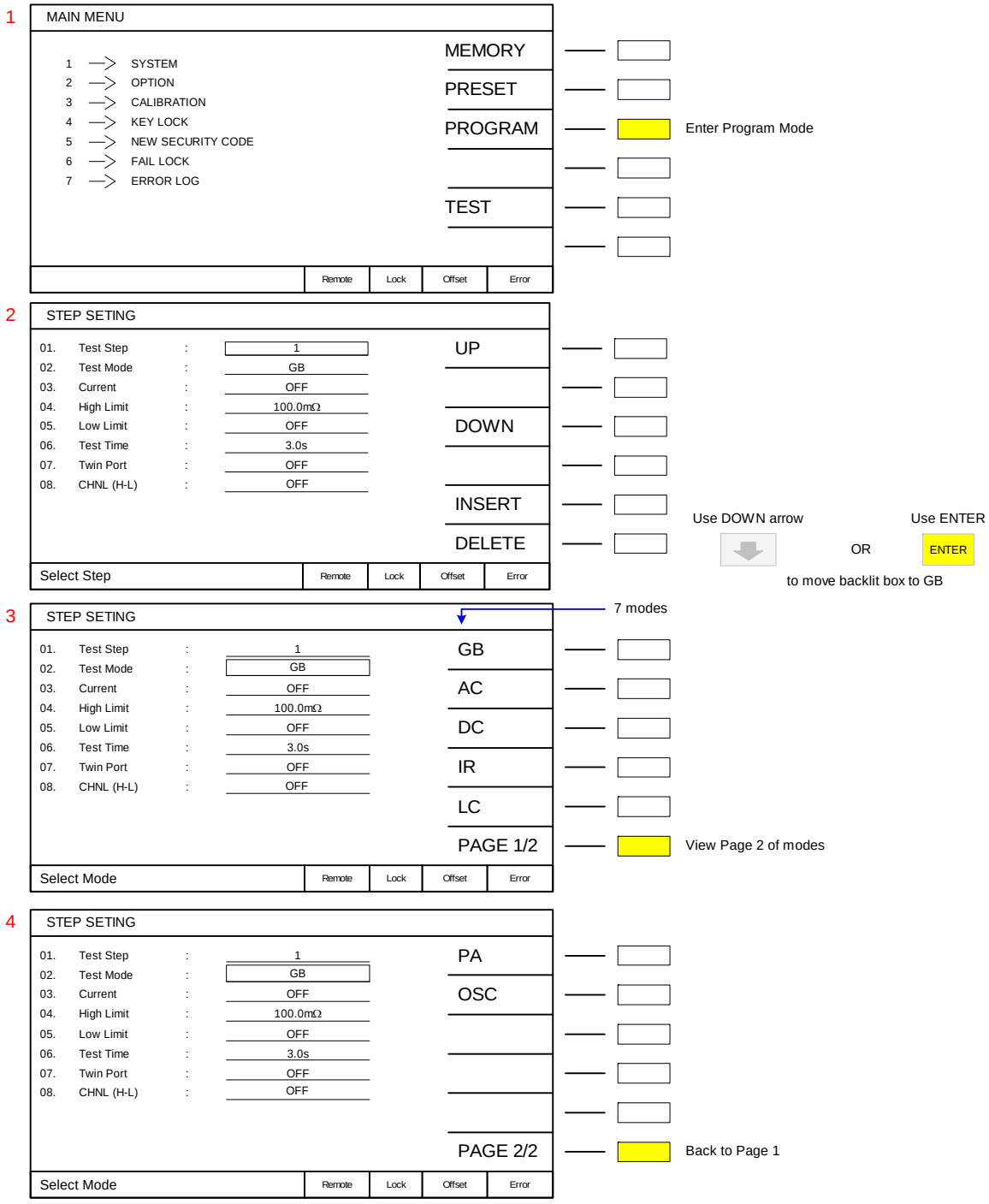


Figure 2-5: Program Menu

Table 2-5: Program Parameters

	GB	AC Hipot	DC Hipot	LC	IR	PA	OSC
1	Test Step	Test Step	Test Step	Test Step	Test Step	Test Step	Test Step
	1-50	1-50	1-50	1-50	1-50	1-50	1-50
2	Test Mode	Test Mode	Test Mode	Test Mode	Test Mode	Test Mode	Test Mode
	GB	AC	DC	LC	IR	PA	OSC
3	Current	Voltage	Voltage	Device	Voltage	Message	Open Check
	1-60A	0.05-5kV	0.05-6kV	UL544NP, 544P, 1563, 2601, 1950	0.05-1kV	13 charc	10-100%
4	High Limit	High Limit	High Limit	Line Input	Low Limit	Under Test	Short Check
	0.1–510mΩ	0.001-40mA	0.0001-12mA	Normal, Reverse, SF-N, SF-R	0.1-50000MΩ	On/Off	0, 100-500%
5	Low Limit	Low Limit	Low Limit	GB Switch	High Limit		CHNL (H-L)
	0-100mΩ	0 - 40mA	0 - 12mA	Open/Closed	0-50000MΩ		1, 3
6	Test Time	Arc Limit	Dwell Time	High Limit	Test Time		
	0, 0.3-999s	1-20mA	0-999s	0.0001-10mA*	0, 0.3-999s		
7	Twin Port	Arc Filter	Arc Limit	Low Limit	Ramp Time		
	On/Off	3-230kHz	1-10mA	0-10mA*	0-999s		
8	CHNL (H-L)	Test Time	Arc Filter	Power	CHNL (H-L)		
	OFF N/A	0, 0.3-999s	3-230kHz	V, A, VA, Simulate	1, 3		
9		Ramp Time	Test Time	Power High			
		0-999s	0, 0.3-999s	0-300V, 0-20A, 0-4400VA, 80-300V			
10		CHNL (H-L)	Ramp Time	Power Low			
		1, 3	0-999s	0-300V, 0-20A, 0-4400VA, N/A			
11			CHNL (H-L)	Test Time			
			1, 3	0, 0.3-999s			
				CHNL (H-L)			
				3			

* 6mA Limit for UL544NP Circuit Model

Note – Moving through Menus

The Function Keys allow you to select the backlit item. Use the [↑] and [↓] arrow keys or the [ENTER] key to move up and down the list.

Note:

In any of the menus, when the text appears ghost-like "CHNL (H-L)" with dashed lines it means that optional function is not installed and unavailable.

If programmed sequentially, paragraphs 2.4.1 through 2.4.6 illustrate a 7-step test as listed in Table 2-6 and detailed in paragraph 2.4.7, "Programming a Multi-Step Test". Test parameters must be programmed before instrument offset is performed.

Table 2-6: Multi-Step Program Example

Step	1	2	3	4	5	6	7
Mode	GB	OSC	AC	PA	DC	IR	LC
3	I = 30A	Open: 50%	V= 1.5kV	Change Lead	V= 2.4kV	V = 1kV	UL2601
4	HL = 100mΩ	Short: 300%	HL= 0.5mA	UT: On	HL= 0.5mA	LL=10000MΩ	Normal
5	LL = Off	CHNL: X	LL = Off		LL = Off	HL = Off	GB Sw: Open
6	Test: 3s		Arc: Off		Dwell: 3s	Test: 3s	M: L-G
7	Twin Port: Off		Fil: 3-230kHz		Arc: Off	Ramp: 3s	HL = 6mA
8	CHNL: OFF		Test: 3s		Fil: 3-230kHz	CHNL: X	LL = Off
9			Ramp: 3s		Test: 3s		P=V
10			CHNL: X		Ramp: 3s		PH = 300V
11					CHNL: X		PL = 0V
							Test: 3s
							CHNL:

If the multi-step example of Table 2-6 is followed, then the resultant test display will be as illustrated Figure 2-6. Step-by-step program instructions are in paragraphs 2.4.1 through 2.4.7 and test instructions are in paragraph 2.7.

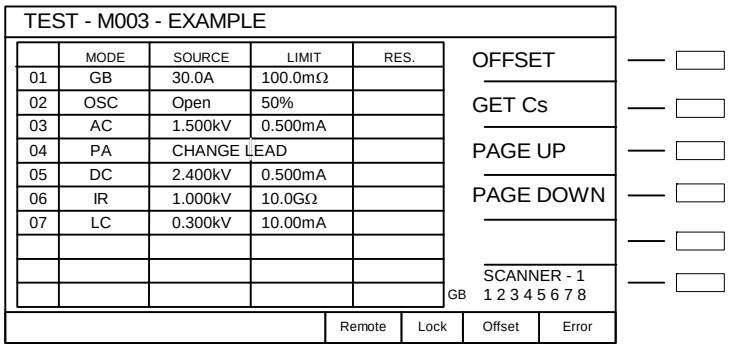


Figure 2-6: Multi-Step Example Test Screen

Floating Ground:

The HV Output terminal on the rear panel of the Guardian 6000 Plus is used to make a floating ground connection to the device under test. It is referred to as Channel 3 and is programmed H (High), L (Low) or X (Off) in the last step of OSC, AC, DC and IR modes. When set to H (high), high voltage is output from Channel 3. When set to L (low), Channel 3 is ground and Drive- is floating. Floating ground can be useful when testing multiple points where the ground should not be included in the test.

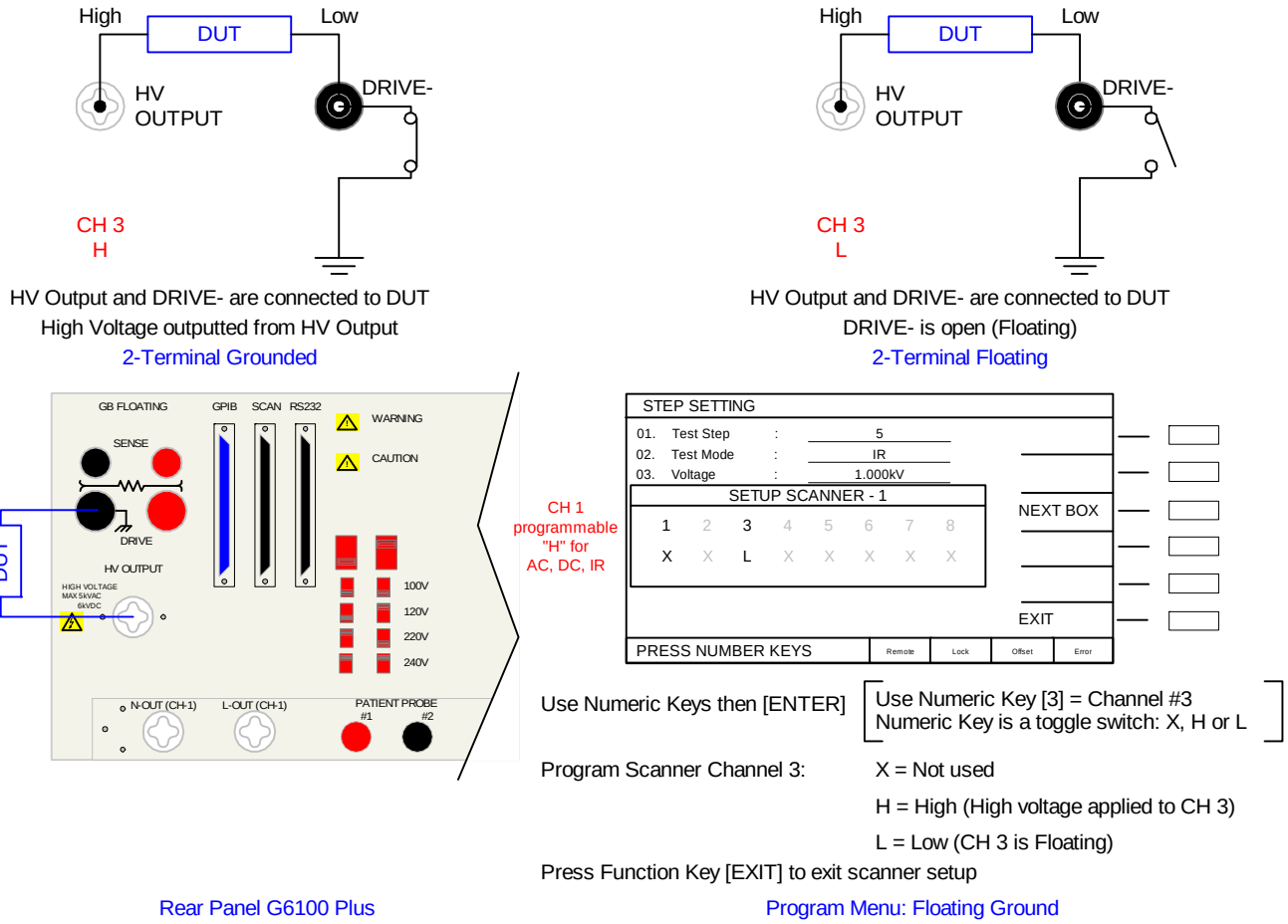


Figure 2-7: Floating Ground 2-Terminal Connection

Table 2-7: GB Floating – Rear Output Only

HV Output – Fixed Channel 3	Setting:	H (HV); L (Low) or X (Off)
	Max Voltage:	5kV AC; 6kV DC
	Max Current:	40mA AC; peak DC
Ground Bond Output – Floating Ground	Setting:	Close; Open
	Max Floating Voltage:	1000V rms; 1400V AC peak
	Max Current:	30A when GB Closed

NOTE:
Due to GB Floating Connection on the rear panel, external scanner connections must be made to the front panel connectors.

2.4.1 Programming a Ground Bond (GB) Test

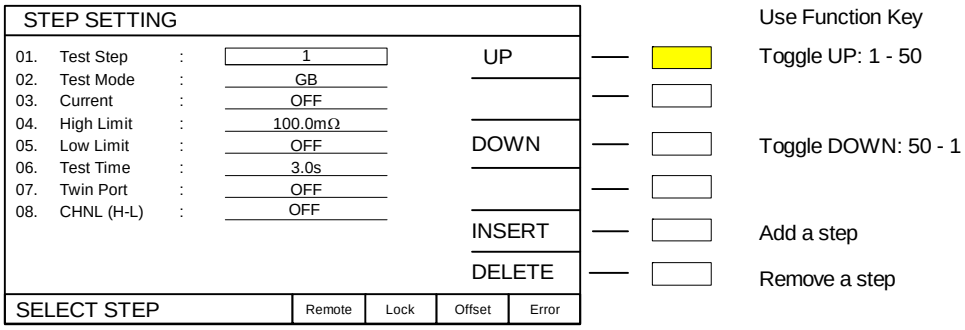
In a GB test, high AC current is applied between a conductive surface of the DUT and ground connection. The ground circuit resistance is then calculated and displayed. A high limit is required in a GB test. The high limit is the upper value for the test to be considered a PASS. If the measured value is higher than the high limit the test is considered a FAIL.

Note – Moving through Menus

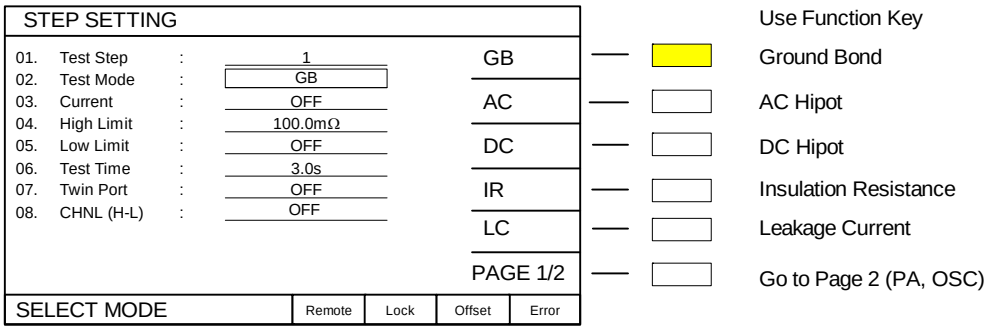
The Function Keys allow you to select the backlit item. Use the [↑] and [↓] arrow keys or the [ENTER] key to move up and down the list.

Press [MENU] to access the PROGRAM menu
Press the function key [PROGRAM]

Press the function key [UP] or [DOWN] to select Step # = 1



Press DOWN arrow [⇓]

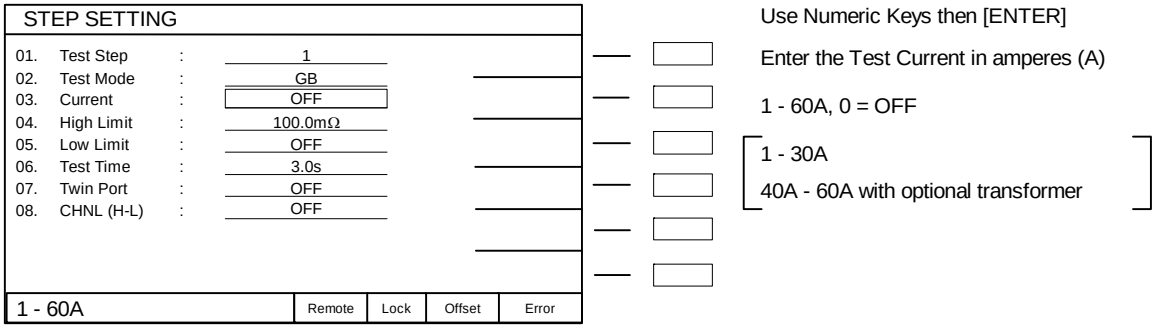


Press the function key [GB] to select mode = Ground Bond

Continued on next page.

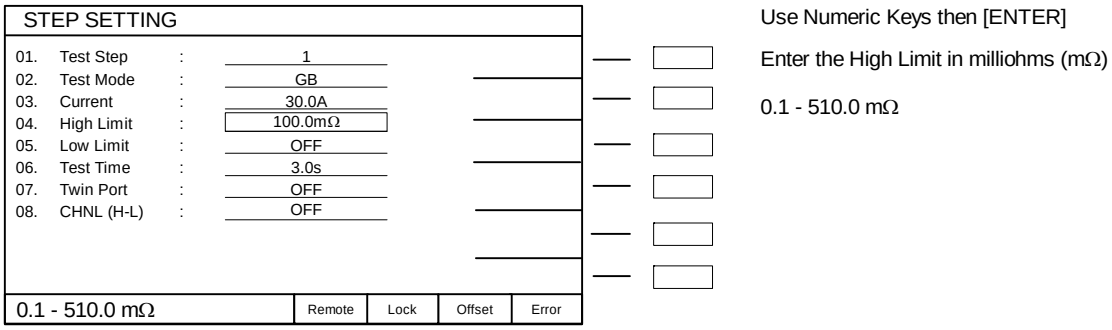
GB Programming – continued from last page.

Press DOWN arrow [⇓]



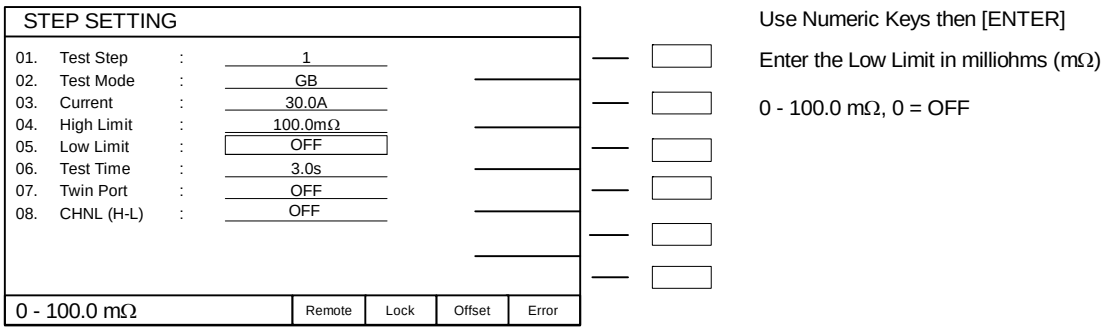
Press [3][0][ENTER] to set current = 30A

Press DOWN arrow [⇓]



Press [1][0][0][ENTER] to set high limit = 100mΩ

Press DOWN arrow [⇓]

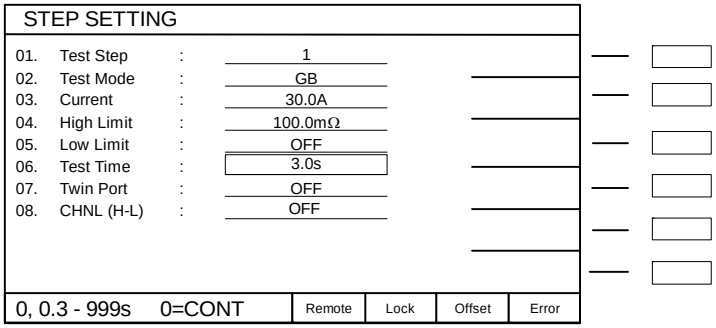


Press [0][ENTER] to set low limt = OFF

Continued on next page.

GB Programming – continued from last page.

Press DOWN arrow [⇓]



Use Numeric Keys then [ENTER]

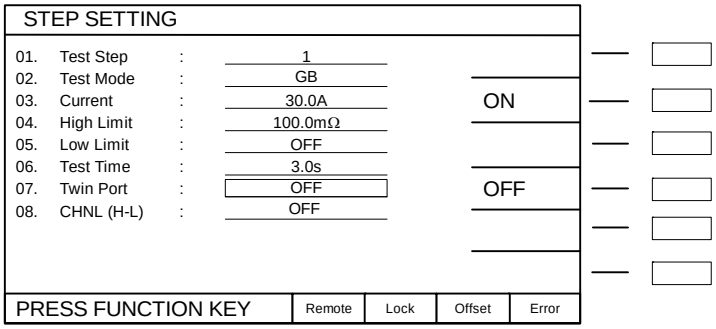
Enter the Test Time in seconds (s)

0, 0.3 - 999s 0 = Continuous

Press [3][.][0] to set the test time = 3.0 seconds

> Note:
> To illustrate the 7 separate modes in this example, Twin Port will be turned OFF. OSC cannot be used when Twin Port is ON. For Twin Port details refer to ¶2.4.1.1.

Press DOWN arrow [⇓]



Use Function Key

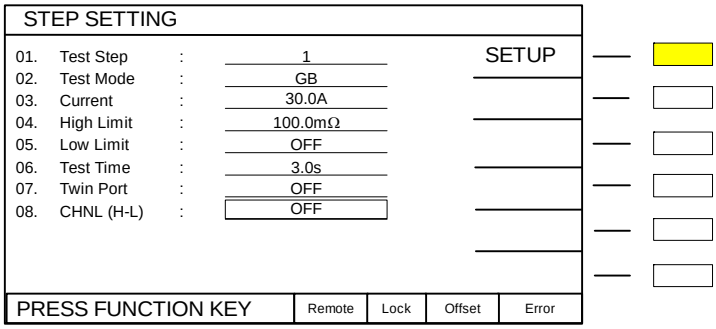
Select Twin Port ON or OFF

ON: GB & Hipot/IR Tests performed simultaneously

OFF: Tests performed singularly

Press the function key [OFF] to perform GB and AC separately (for this example)

Press DOWN arrow [⇓]



Use Function Key

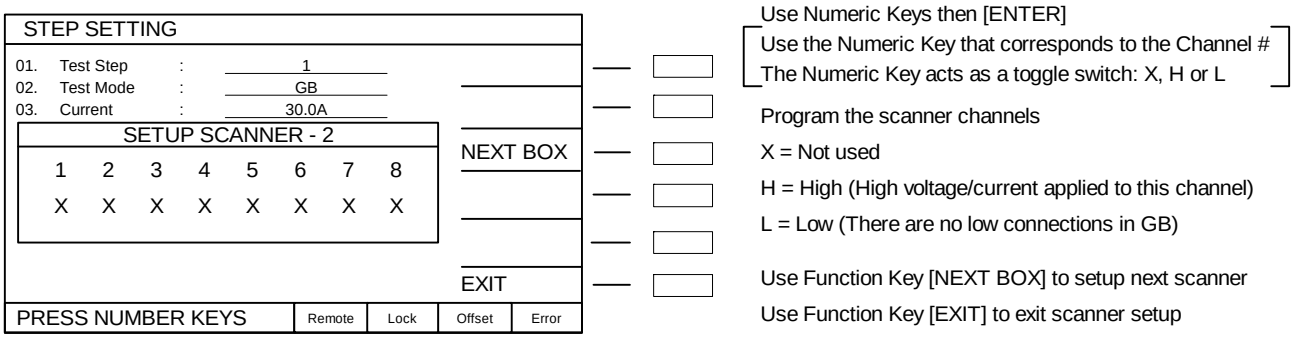
Enter setup menu for scanner(s)

Continued on next page.

GB Programming – continued from last page.

NOTE:
Scanner #1 is the 6000-07 Leakage Current Scanner. It can not be programmed for GB.

Press the function key [SETUP] to enter scanner setup menu (For External Scanner).



Press [NEXT BOX] to go to Scanner 2
Press [1] to set Channel 1 to H (High). [Set CH 2-8 to H or X per your setup]
Press the function key [EXIT] to return to GB program menu.
The display will read: "CHNL (H-L): 1-RTN"
Press DOWN arrow [⇓]
The backlit box is now again at the top of the list adjacent to "Test Step: 1 ". **STOP.**

There are 2 choices:

1 - To continue programming the 7-step example:
Press the function key [UP] to select Test Step = 2. Instructions continued in ¶ 2.4.2*

OR

2 – End Programming and perform a GB test:
Press [MENU] to exit program mode.
Perform offset (¶ 2.7.1), connect DUT (¶ 2.7.3) then press green [START] button.

2.4.1.1 Twin Port™

The Twin Port function provides simultaneous GB with AC Hipot, DC Hipot or IR testing. When employing the Twin Port function, GB must be the first step in the test sequence. When Twin Port is selected ON, The GB test will be performed at the same time as the AC Hipot, DC Hipot or IR test, whichever is the next step in the sequence.

Caution:
When Twin Port is ON, do not exceed 5kV, 20mA AC or 25A GB. Values higher than this may cause output voltage/current distortion.

2.4.2 Open/Short Circuit (OSC) Detection Mode

The Open/Short Circuit Detection Mode will ensure the Device Under Test is connected properly and does not have a short circuit. In Program mode OSC can be selected as one of the steps within the test. There are two programmable parameters Open % and Short %. Open % is equivalent to a low limit. Short % would be considered a high limit. Once programming is finalized, an offset should be performed and the Get Cs function must be ran to learn the Capacitance of the device under test. This learned Capacitance value will then be compared to the Open % and Short % for Pass/Fail judgment. This function is typically programmed prior to a hipot test to check the connection to the device under test before applying high voltage.

Open Check: In hipot testing, a low leakage current may generate a PASS. If the connection is faulty between the hipot and the DUT, the test could pass even if the DUT was not tested. Open Check is similar to using a low limit in an AC hipot test to ensure the connection of the DUT. In some cases, such as DC Hipot, a low limit is not feasible. Open Check will ensure that the DUT is connected.

The Open Check sets the judgment test result (Pass/Fail) to open circuit condition and compares the test reading with the standard capacitance value (Cs). If the test reading is within the programmed % then the judgment is Pass. The Open Check can be programmed from 10% - 100% and the default 50%.

Short Check: In some cases, the DUT is shorted prior to testing. If the product is shorted, there is no need to perform hipot.

The Short Check sets the judgment test result (Pass/Fail) to short circuit condition and compares the test reading to the standard capacitance value (Cs). If the test reading is within the programmed % then the judgment is Pass. The Short Check can be set to Off or programmed from 100% - 500%. The default value is 300%. When using OSC mode, program the test, attach the DUT and press [GET Cs] to obtain the DUT's standard capacitance value. The Cs value is saved with the test program in instrument memory. The Cs value is applicable to that product only.

To illustrate this function: for a particular DUT, the Guardian instrument learned Cs = 0.241nF and the Open Check is set to 50%. If the measured Cs is within 50% of the learned Cs, then the OSC result is a PASS. If the measured Cs is greater than 0.121nF (50% of .241nF), then the OSC result is a PASS. If the measured Cs is less than 0.121nF, then the OSC result is an OPEN. If the Short Check is set to 300%. If the measured Cs is less than 300% of the learned Cs, then the OSC result is a PASS. If the measured Cs is greater than 300% of the learned Cs, then the OSC result is a FAIL. If the measured Cs is greater than 0.723nF (300% of .241nF), then the OSC result is a SHORT.

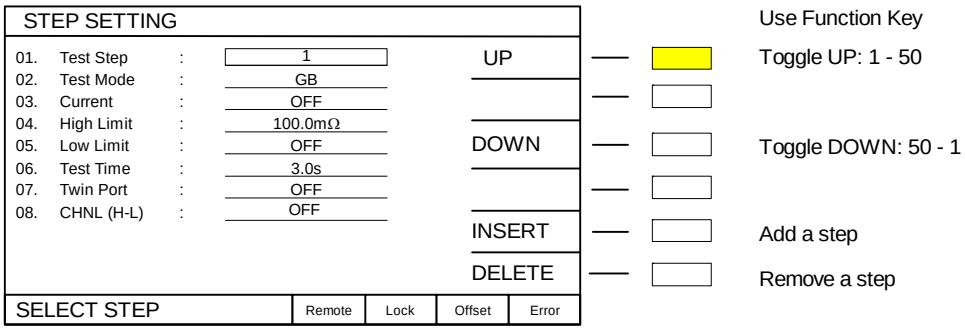
NOTE:
To obtain consistent results, the Offset function must be performed when using the OSC mode. The Offset function is performed prior to the Get Cs function.

Back to programming OSC mode. If not already in PROGRAM mode:

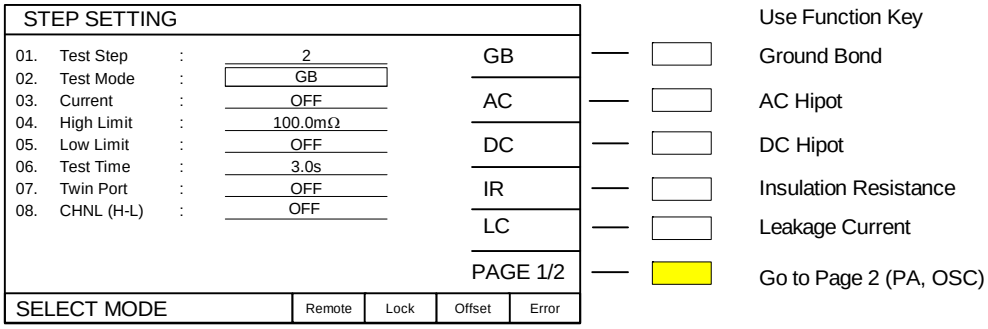
Press [MENU] to access the PROGRAM menu
Press the function key [PROGRAM]

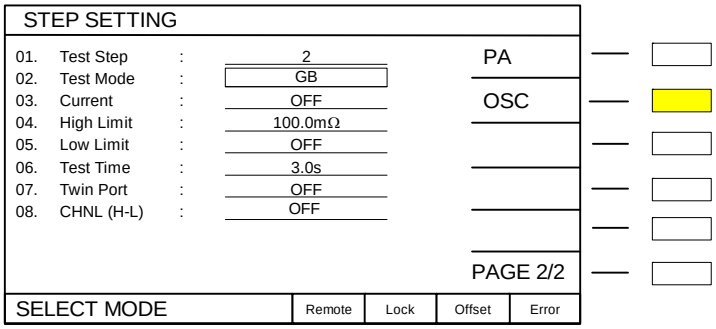
If continuing example:

* Press the function key [UP] to select Step # = 2



Press DOWN arrow [⇓]



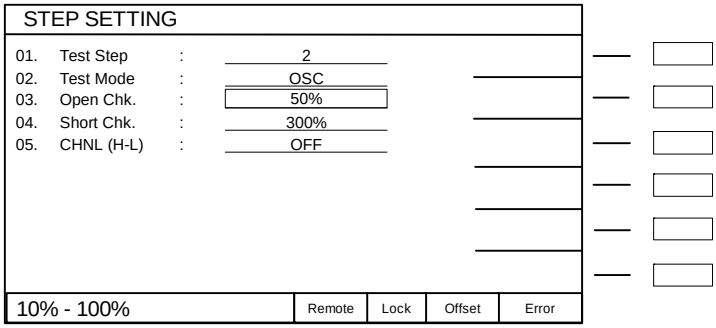


Press the function key [PAGE1/2] then [OSC] to select mode = Open/Short Circuit

Continued on next page.

OSC Programming – continued from last page.

Press DOWN arrow [⇓]



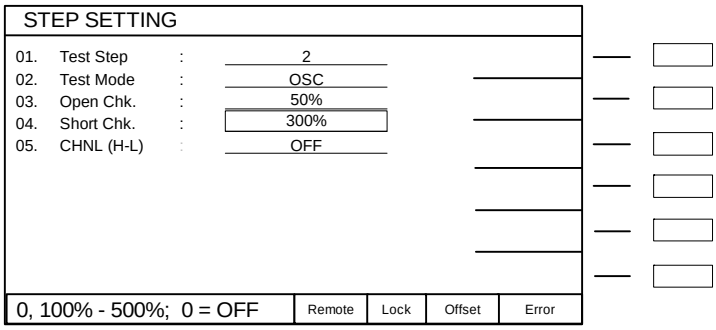
Use Numeric Keys then [ENTER]

Enter the Open comparison value in percent (%)

10% - 100%, default = 50%

Press [5][0][ENTER] to set the Open Check = 50%

Press DOWN arrow [⇓]



Use Numeric Keys then [ENTER]

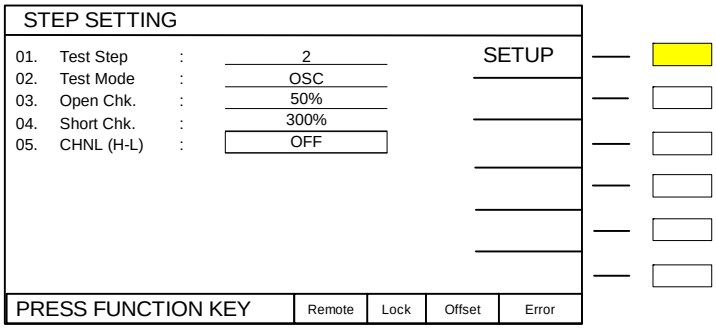
Enter the Short comparison value in percent (%)

0, 100% - 500%; 0 = OFF, default = 300%

Press [3][0][0][ENTER] to set the Short Check = 300%

Press DOWN arrow [⇓]

Display reads: “05. CHNL (H-L) : OFF”



Use Function Key

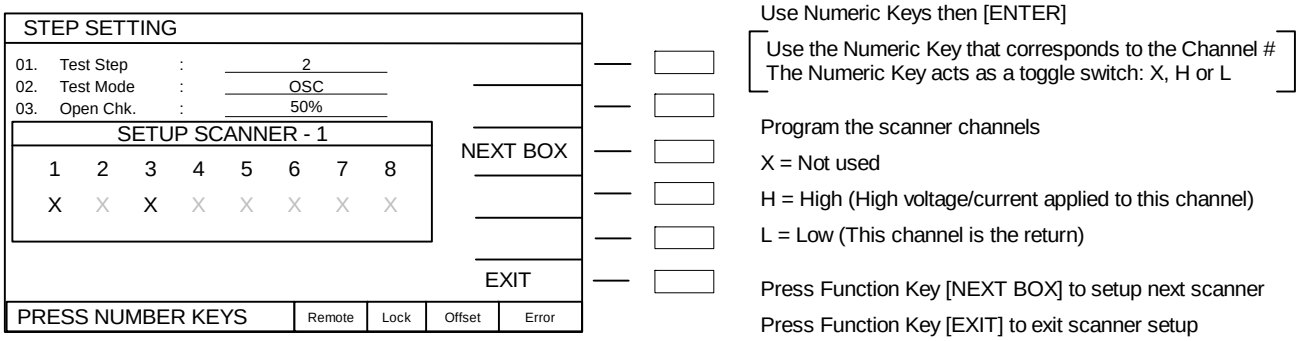
Enter setup menu for scanner(s)

Press the function key [SETUP] to enter scanner setup menu

Continued on next page.

OSC Programming – continued from last page.

Scanner #1 is the internal 6000-07 Hipot/Leakage Current Scanner. In OSC mode, only Channels 1 and 3 are available on Scanner #1. CH1 can be set to H or X. CH3 can be set to H, L or X.



Press [1] to set Channel 1 to H (High)
Press [3] twice to set Channel 3 to L (Low)
This will check the connection between channels 1 and 3.
Press the function key [EXIT] to return to OSC program menu.
Press DOWN arrow [⇓]
The backlit box is now again at the top of the list adjacent to "Test Step: 2 ". **STOP.**

To continue programming the 7-step example:
Press the function key [UP] to select Test Step = 3. Instructions continued in ¶ 2.4.3*

OR

To End Programming and perform an OSC test:
Press [MENU] to exit program mode.
Perform offset (¶2.7.1), perform Get Cs (¶2.7.2), connect DUT (¶2.7.3) then press green [START] button.

2.4.3 Programming an AC Hipot Test

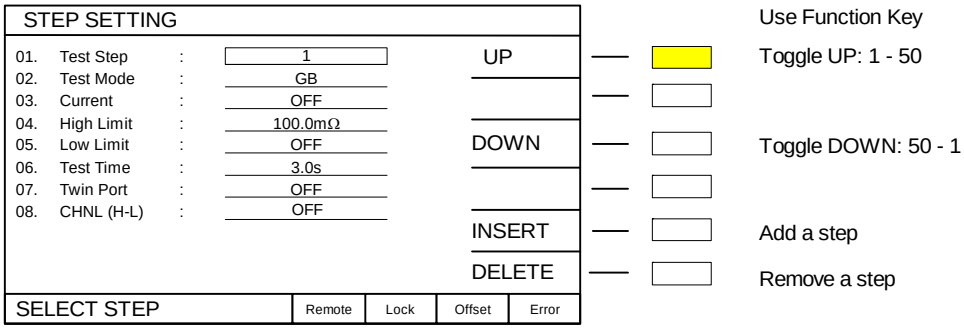
In an AC hipot test, high AC voltage is applied between the DUT's operating circuits and chassis ground to determine if/when a breakdown will occur in the insulation of the DUT. The current is measured between the DUT insulation and ground. A high limit is required in an AC test. The high limit is the maximum allowed value for the test to be considered a PASS. If the measured value is higher than the high limit the test is considered a FAIL.

If not already in PROGRAM mode:

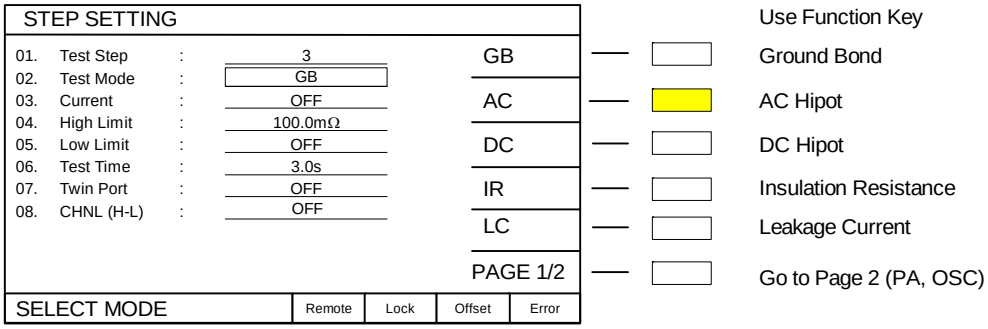
Press [MENU] to access the PROGRAM menu
Press the function key [PROGRAM]

If continuing example:

* Press the function key [UP] or [DOWN] to select Step # = 3



Press DOWN arrow [⇓]

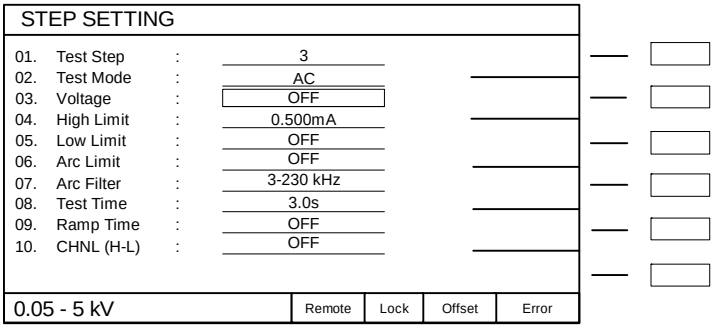


Press the function key [AC] to select mode = AC Hipot

Continued on next page.

AC Hipot Programming – continued from last page.

Press DOWN arrow [⇓]



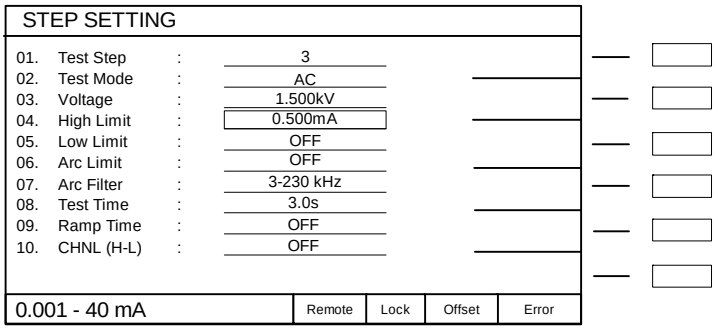
Use Numeric Keys then [ENTER]

Enter the Test Voltage in kilo-volts (kV)

0.05 - 5 kV (50 - 5000 V)

Press [1][.][5][0][0][ENTER] to set voltage = 1.500kV

Press DOWN arrow [⇓]



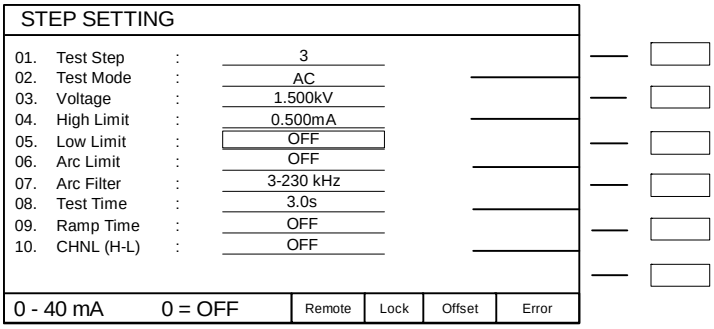
Use Numeric Keys then [ENTER]

Enter the High Limit in milli-amps (mA)

0.001 - 40 mA

Press [0][.][5][0][0][ENTER] to set high current limit = 0.500mA

Press DOWN arrow [⇓]



Use Numeric Keys then [ENTER]

Enter the Low Limit in milli-amps (mA)

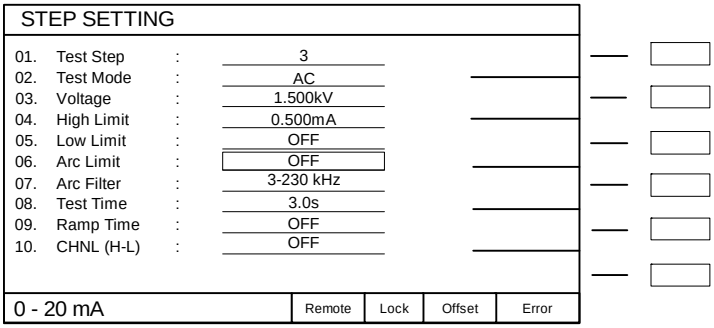
0 - 40 mA, 0 = OFF

Press [0][ENTER] to set low current limit = OFF

Continued on next page.

AC Hipot Programming – continued from last page.

Press DOWN arrow [⇓]



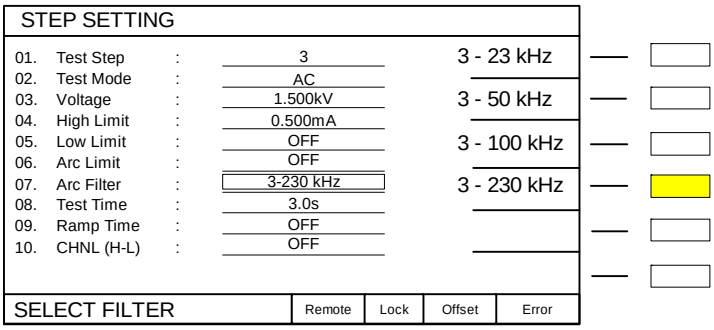
Use Numeric Keys then [ENTER]

Enter the Arc Limit in milli-amps (mA)

0 - 20 mA, 0 = OFF

Press [0][ENTER] to set arc current limit = OFF

Press DOWN arrow [⇓]



Use Function Keys

Select the Arc Filter Frequency in kilo-hertz (kHz)

3 -23 kHz (40µs)

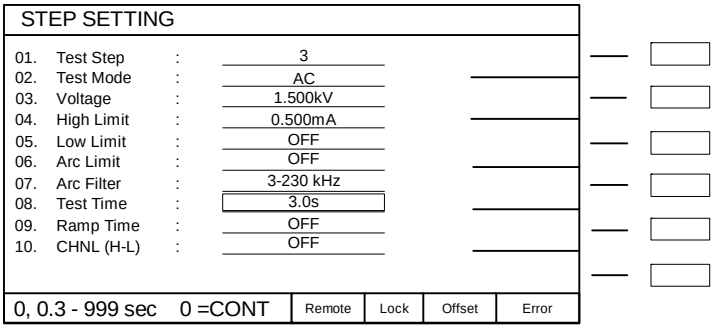
3 -50 kHz (20µs)

3 -100 kHz (10µs)

3 -230 kHz (4µs)

Press the function key [3 -230 kHz] to set arc filter frequency = 3 – 230kHz

Press DOWN arrow [⇓]



Use Numeric Keys then [ENTER]

Enter the Test Time in seconds (s)

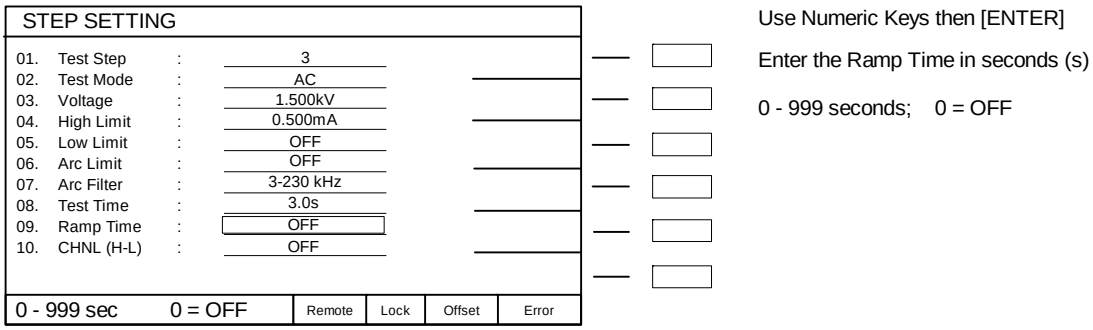
0, 0.3 - 999 seconds; 0 = Continuous

Press [3][.][0][ENTER] to set test time = 3.0s

Continued on next page.

AC Hipot Programming – continued from last page.

Press DOWN arrow [⇓]



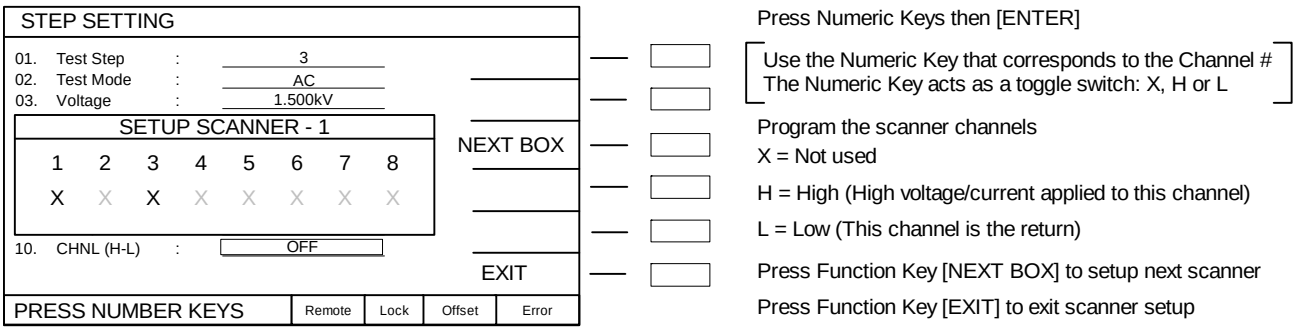
Press [3][.][0][ENTER] to set ramp time = 3.0s

Press DOWN arrow [⇓]

Display reads: "10. CHNL (H-L) : OFF"

Scanner #1 is the internal 6000-07 Hipot/Leakage Current Scanner. In AC mode, only Channels 1 and 3 are available on Scanner #1. CH1 can be set to H or X. CH3 can be set to H, L or X.

Press the function key [SETUP] to enter scanner setup menu.



Press [1] to set Channel 1 to H (High); Press [3] twice to set Channel 3 to L (Low)
Press the function key [EXIT] to return to AC program menu.
Press DOWN arrow [⇓]
The backlit box is now again at the top of the list adjacent to "Test Step: 3 ". **STOP.**

To continue programming the 7-step example:
Press the function key [UP] to select Test Step = 4. Instructions continued in ¶ 2.4.4*

OR

To End Programming and perform an AC test:
Press [MENU] to exit program mode.
Perform offset (¶2.7.1), perform Get Cs(¶2.7.2), connect DUT (¶2.7.3) then press green [START] button.

2.4.4 Pause (PA) Mode

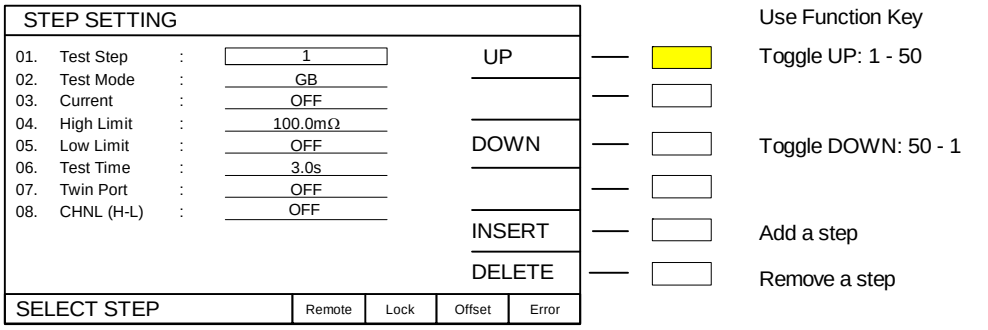
"PAUSE" is a mode selection that allows a test sequence to be stopped while test leads are changed or other operations performed. A 13-character user programmable message will be displayed on the screen when in PAUSE mode and the test will continue when the [START] button is pressed or START initiated via remote I/O. The Under Test relay on the remote I/O can also be cycled during PAUSE if required.

If not already in PROGRAM mode:

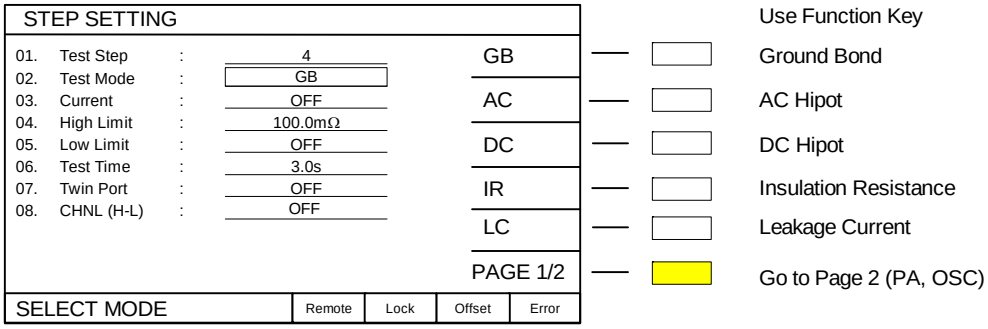
Press [MENU] to access the PROGRAM menu
Press the function key [PROGRAM]

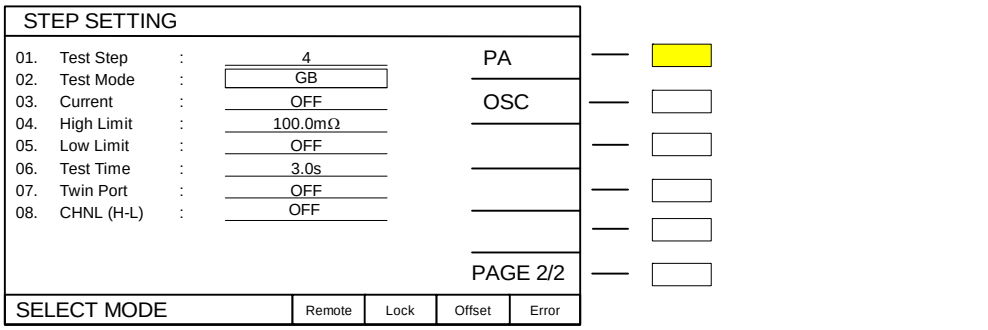
If continuing example:

* Press the function key [UP] to select Step # = 4



Press DOWN arrow [⇓]

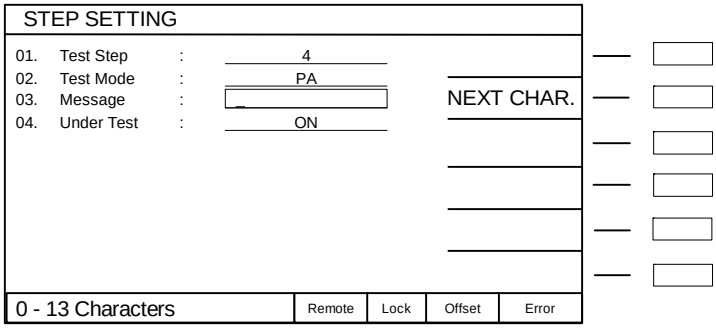




Press the function key [PAGE1/2] then [PA] to select mode = Pause

PA Programming – continued from last page.

Press DOWN arrow [⇓]



Use Function Key to move cursor to next character

Use Numeric Keys then [ENTER]

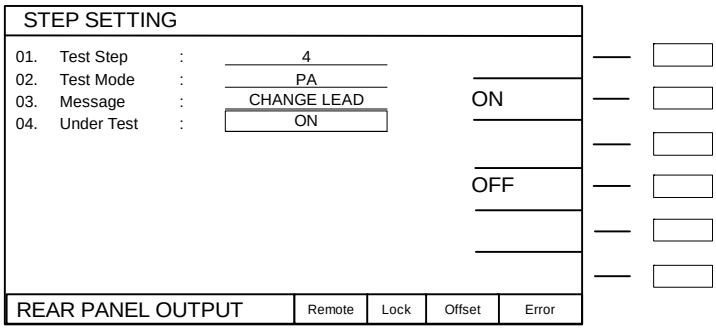
Enter the Message: 0 - 13 alpha-numeric characters

PRESS

[1] 4x → C [ENTER] [NEXT CHAR]
[3] 3x → H [ENTER] [NEXT CHAR]
[1] 2x → A [ENTER] [NEXT CHAR]
[5] 3x → N [ENTER] [NEXT CHAR]
[3] 2x → G [ENTER] [NEXT CHAR]
[2] 3x → E [ENTER] [NEXT CHAR]
_ [NEXT CHAR]
[4] 4x → L [ENTER] [NEXT CHAR]
[2] 3x → E [ENTER] [NEXT CHAR]
[1] 2x → A [ENTER] [NEXT CHAR]
[2] 2x → D [ENTER]

Enter Pause Message: "CHANGE LEAD"

Press DOWN arrow [⇓]



Use Function Key

Enter the status of the Rear Panel Output

ON or OFF

Press the function key [OFF] to set Under Test relay = ON

Press DOWN arrow [⇓]
The backlit box is now again at the top of the list adjacent to "Test Step: 4 ". **STOP.**

To continue programming the 7-step example:
Press the function key [UP] to select Test Step = 5. Instructions continued in ¶ 2.4.5*

OR

To End Programming and review PA mode:
Press [MENU] to exit program mode.
Perform offset (¶ 2.7.1), connect DUT (¶ 2.7.3) then press green [START] button.

2.4.5 Programming a DC Hipot Test

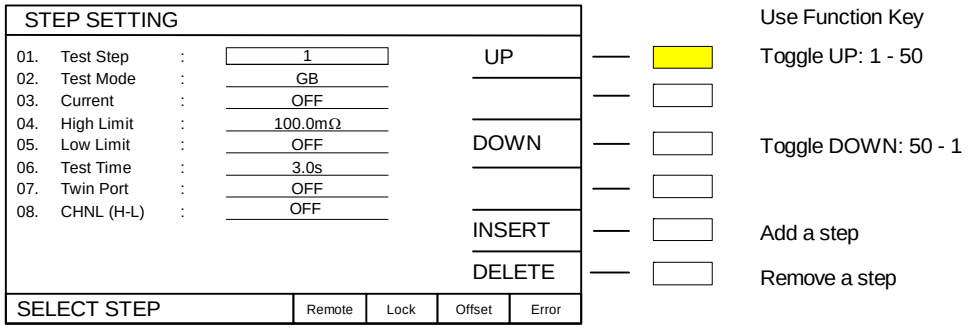
In a DC hipot test, high DC voltage is applied between the DUT's operating circuits and chassis ground to determine if/when a breakdown will occur in the insulation of the DUT. The current is measured between the DUT insulation and ground. A high limit is required in a DC test. The high limit is the maximum allowed value for the test to be considered a PASS. If the measured value is higher than the high limit the test is considered a FAIL.

If not already in PROGRAM mode:

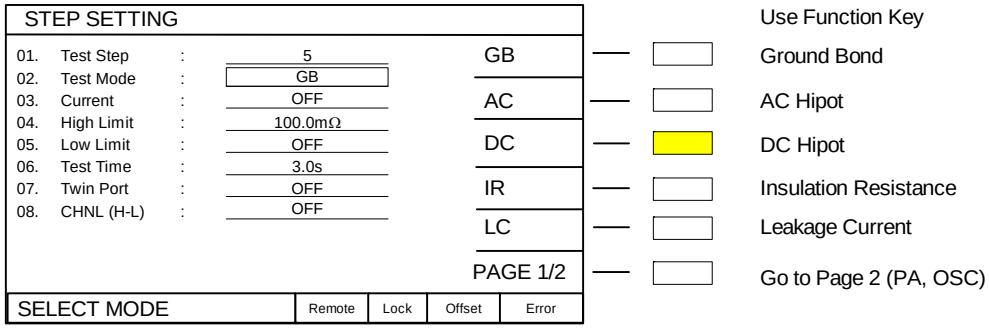
Press [MENU] to access the PROGRAM menu
Press the function key [PROGRAM]

If continuing example:

* Press the function key [UP] or [DOWN] to select Step # = 5



Press DOWN arrow [⇓]

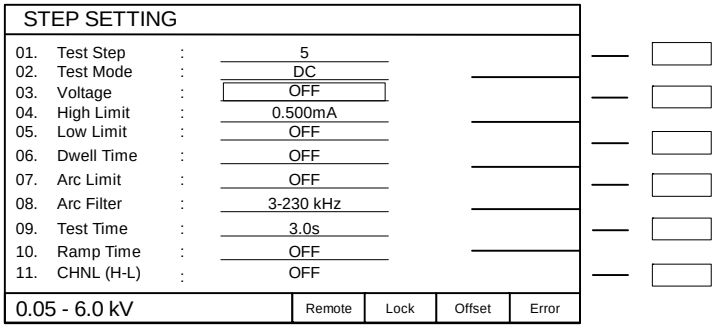


Press the function key [DC] to select mode = DC Hipot

Continued on next page.

DC Hipot Programming – continued from last page.

Press DOWN arrow [⇓]



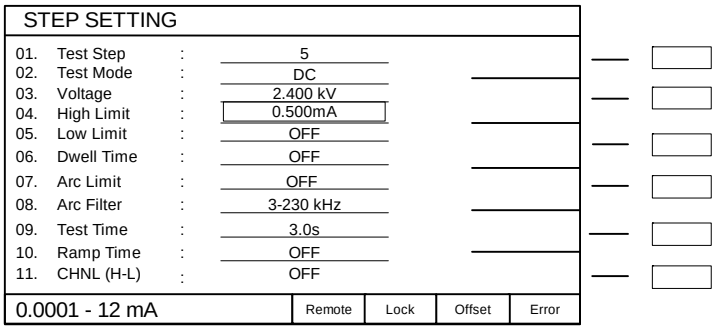
Use Numeric Keys then [ENTER]

Enter the Test Voltage in kilo-volts (kV)

0.05 - 6.0 kV (50 - 6000V)

Press [2][.][4][0][0][ENTER] to set voltage = 2.400kV

Press DOWN arrow [⇓]



Use Numeric Keys then [ENTER]

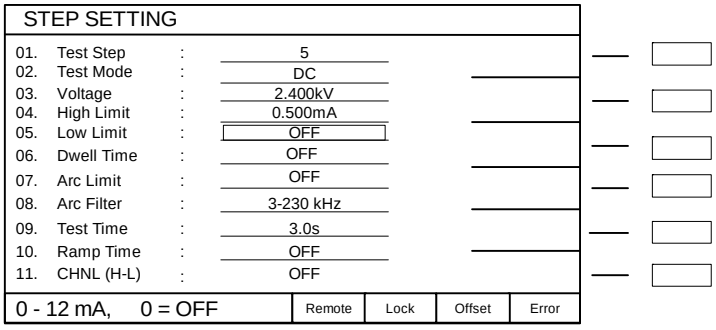
Enter the High Limit in milliamps (mA)

0.0001 - 12 mA

Note: Setting the High Limit will determine the measurement range:
<.300mA = Low range
.300 < 3.00mA = Mid range
≥ 3.00mA = High range

Press [0][.][5][0][0][ENTER] to set high current limit = 0.500mA

Press DOWN arrow [⇓]



Use Numeric Keys then [ENTER]

Enter the Low Limit in milliamps (mA)

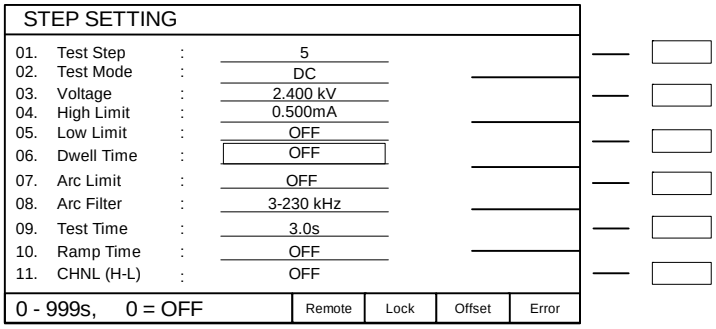
0 - 12 mA, 0 = OFF

Press [0][ENTER] to set low current limit = OFF

Continued on next page.

DC Hipot Programming – continued from last page.

Press DOWN arrow [⇓]



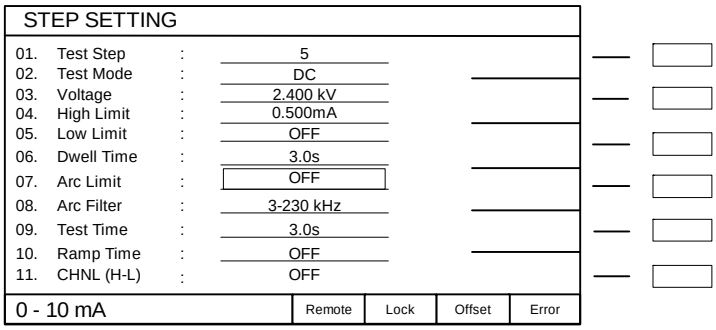
Use Numeric Keys then [ENTER]

Enter the Dwell Time in seconds (s)

0 - 999 seconds; 0 = OFF

Press [3][.][0][ENTER] to set dwell time = 3.0s

Press DOWN arrow [⇓]



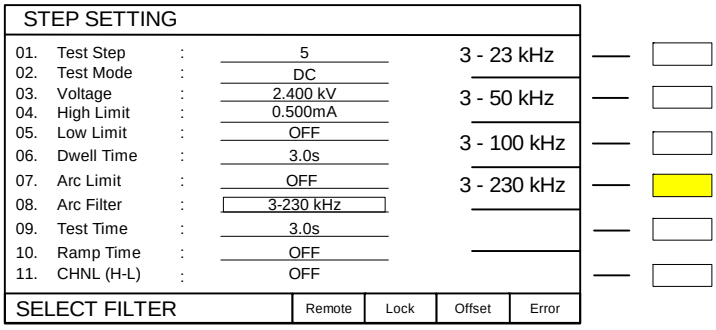
Use Numeric Keys then [ENTER]

Enter the Arc Limit in milli-amps (mA)

0 - 10 mA, 0 = OFF

Press [0][ENTER] to set arc current limit = OFF

Press DOWN arrow [⇓]



Use Function Keys

Select the Arc Filter Frequency in kilo-hertz (kHz)

3 -23 kHz (40µs)

3 -50 kHz (20µs)

3 -100 kHz (10µs)

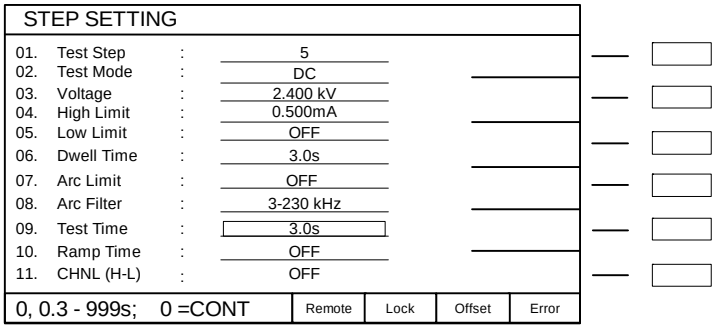
3 -230 kHz (4µs)

Press the function key [3 -230 kHz] to set arc filter frequency = 3 – 230kHz

Continued on next page.

DC Hipot Programming – continued from last page.

Press DOWN arrow [⇓]



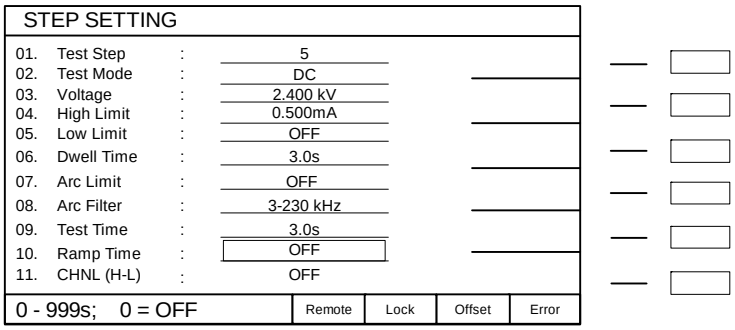
Use Numeric Keys then [ENTER]

Enter the Test Time in seconds (s)

0, 0.3 - 999 seconds; 0 = Continuous

Press [3][.][0][ENTER] to set test time = 3.0s

Press DOWN arrow [⇓]



Use Numeric Keys then [ENTER]

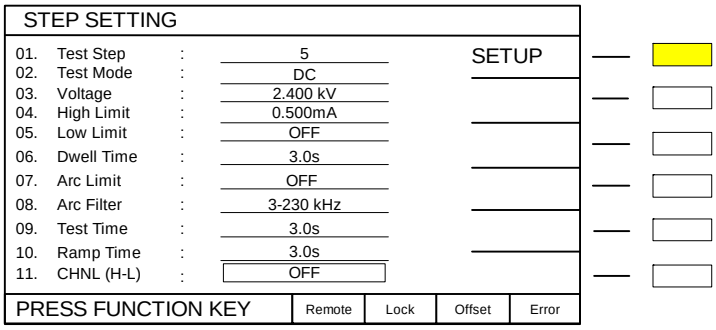
Enter the Ramp Time in seconds (s)

0 - 999 seconds; 0 = OFF

Press [3][.][0][ENTER] to set ramp time = 3.0s

Press DOWN arrow [⇓]

Display reads: “11. CHNL (H-L) : OFF”



Use Function Key

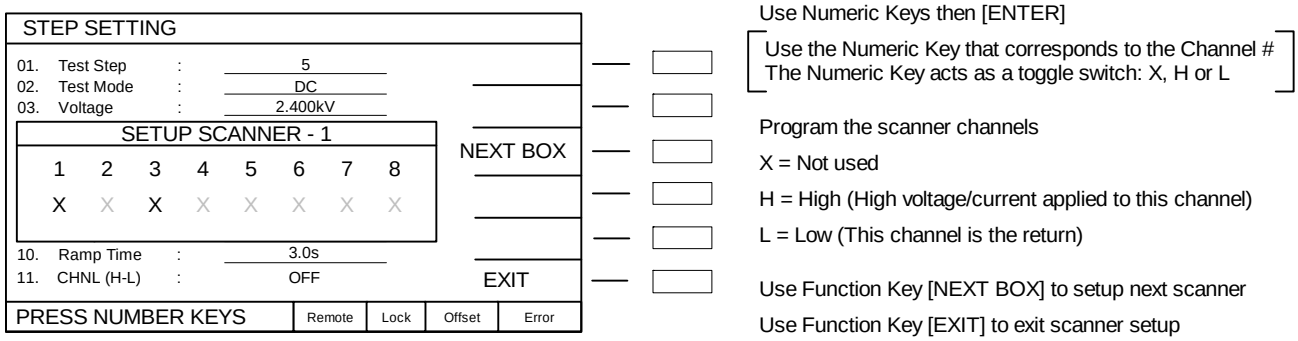
Enter setup menu for scanner(s)

Press the function key [SETUP] to enter scanner setup menu.

Continued on next page.

DC Hipot Programming – continued from last page.

Scanner #1 is the internal 6000-07 Hipot/Leakage Current Scanner. In DC mode, only Channels 1 and 3 are available on Scanner #1. CH1 can be set to H or X. CH3 can be set to H, L or X.



Press [1] to set Channel 1 to H (High)
Press [3] twice to set Channel 3 to L (Low)
Press the function key [EXIT] to return to DC program menu.
Press DOWN arrow [⇓]
The backlit box is now again at the top of the list adjacent to "Test Step: [5]". **STOP.**

To continue programming the 7-step example:
Press the function key [UP] to select Test Step = 6. Instructions continued in ¶ 2.4.6*

OR

To End Programming and perform a DC test:
Press [MENU] to exit program mode.
Perform offset (¶2.7.1), perform Get Cs (¶2.7.2), connect DUT (¶ 2.7.3) then press green [START] button.

2.4.6 Programming an Insulation Resistance (IR) Test

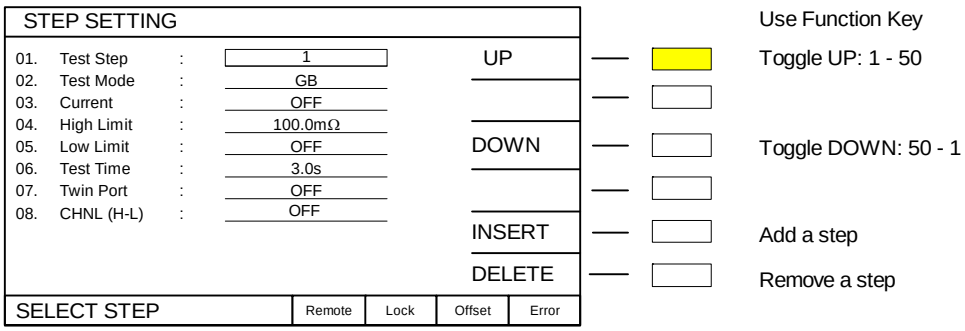
In an IR test, high DC voltage is applied to the DUT to determine strength of the insulation of the DUT. The resistance is measured between the DUT insulation and ground. A low limit is required in an IR test. The low limit is the minimum allowable value for the test to be considered a PASS. If the measured value is lower than the low limit the test is considered a FAIL.

If not already in PROGRAM mode:

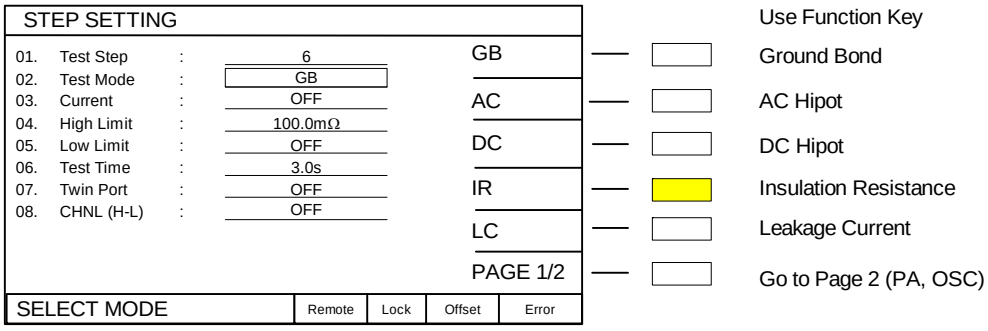
Press [MENU] to access the PROGRAM menu
Press the function key [PROGRAM]

If continuing example:

* Press the function key [UP] to select Step # = 6



Press DOWN arrow [⇓]



Press the function key [IR] to select mode = Insulation Resistance

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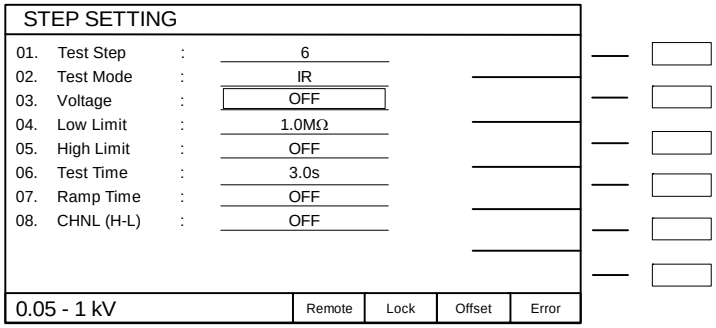
IR Programming – continued from last page.

Press DOWN arrow [⇓]



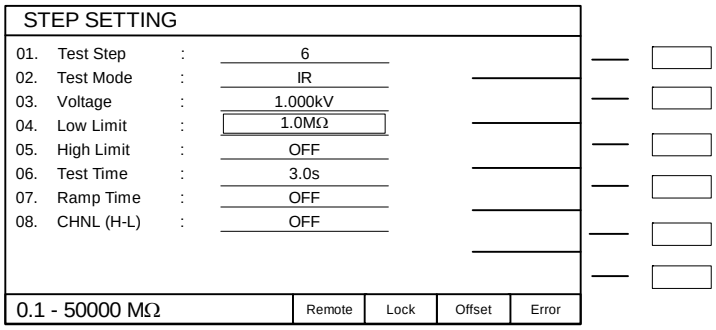
Use Numeric Keys then [ENTER]

Enter the Test Voltage in kilo-volts (kV)

0.05 - 1 kV (50 - 1000V)

Press [1][.][0][ENTER] to set voltage = 1.000kV

Press DOWN arrow [⇓]



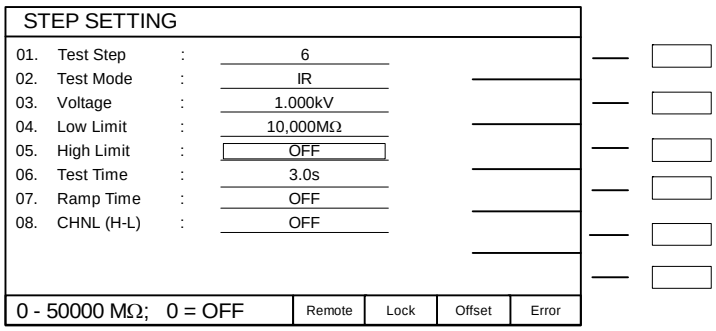
Use Numeric Keys then [ENTER]

Enter the Low Limit in megohms (MΩ)

0.1 - 50,000 MΩ

Press [1][0][0][0][0][ENTER] to set low resistance limit = 10,000MΩ

Press DOWN arrow [⇓]



Use Numeric Keys then [ENTER]

Enter the High Limit in megohms (MΩ)

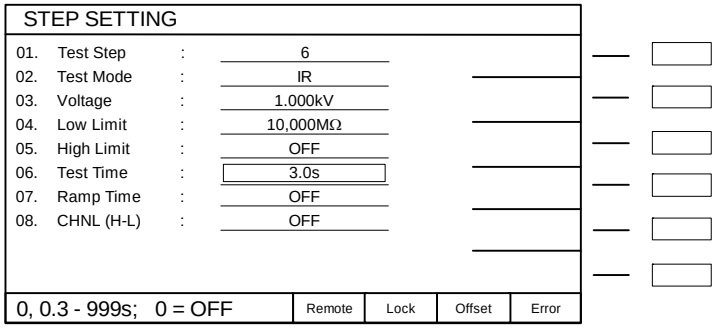
0 - 50,000 MΩ, 0 = OFF

Press [0][ENTER] to set high resistance limit = OFF

Continued on next page.

IR Programming – continued from last page.

Press DOWN arrow [⇓]



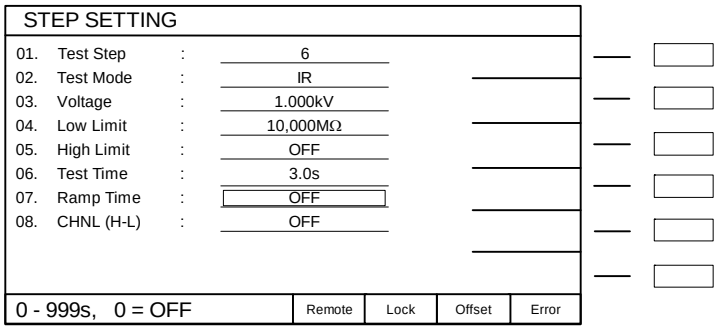
Use Numeric Keys then [ENTER]

Enter the Test Time in seconds (s)

0, 0.3 - 999 seconds; 0 = Continuous

Press [3][.][0][ENTER] to set test time = 3.0s

Press DOWN arrow [⇓]



Use Numeric Keys then [ENTER]

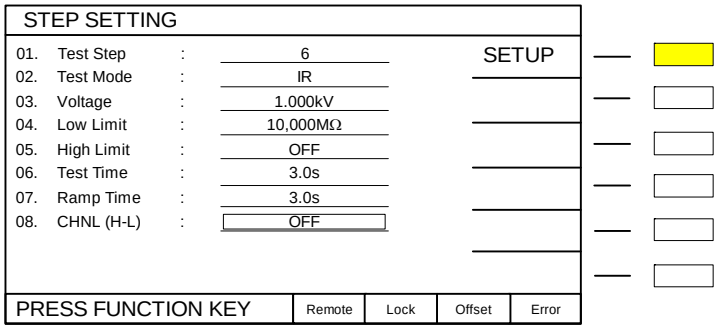
Enter the Ramp Time in seconds (s)

0 - 999 seconds; 0 = OFF

Press [3][.][0][ENTER] to set ramp time = 3.0s

Press DOWN arrow [⇓]

Display reads: "08. CHNL (H-L) : OFF"



Use Function Key

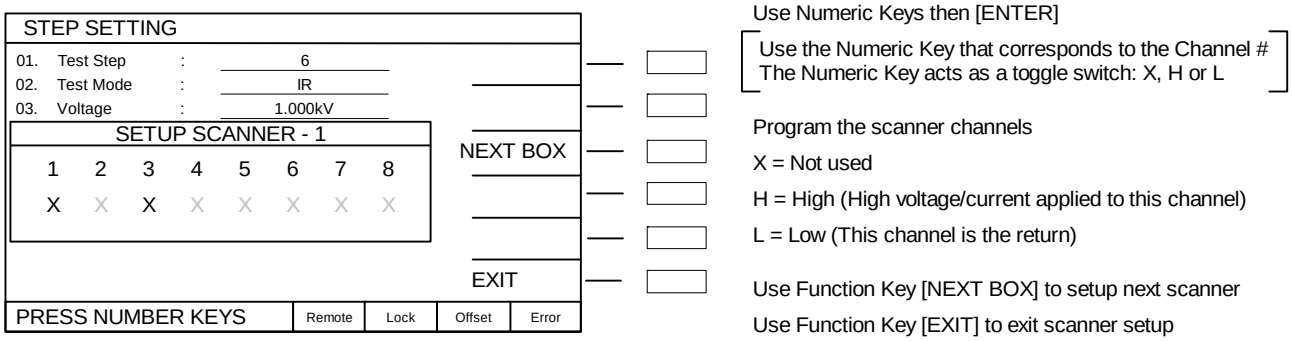
Enter setup menu for scanner(s)

Press the function key [SETUP] to enter scanner setup menu

Continued on next page.

IR Programming – continued from last page.

Scanner #1 is the internal 6000-07 Hipot/Leakage Current Scanner. In IR mode, only Channels 1 and 3 are available on Scanner #1. CH1 can be set to H or X. CH3 can be set to H, L or X.



Press [1] to set Channel 1 to H (High)
Press [3] twice to set Channel 3 to L (Low)
Press the function key [EXIT] to return to IR program menu.
Press DOWN arrow [⇓]
The backlit box is now again at the top of the list adjacent to "Test Step: [6]". **STOP.**

To continue programming the 7-step example:
Press the function key [UP] to select Test Step = 7. Instructions continued in ¶ 2.4.7*

OR

To End Programming and perform an IR test:
Press [MENU] to exit program mode.
Perform offset (¶2.7.1), perform Get Cs (¶2.7.2), connect DUT (¶ 2.7.3) then press green [START] button.

2.4.7 Programming a Leakage Current (LC) Test

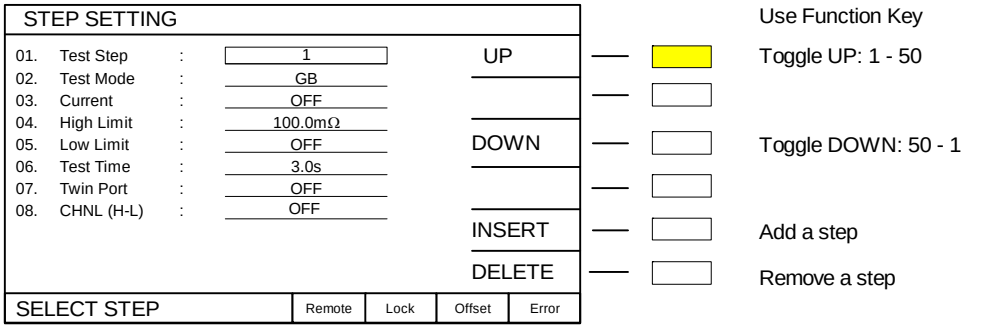
In an LC test, high voltage is applied to the DUT and the resistance is measured between the DUT insulation and ground. A high limit is required in an LC test. The high limit is the maximum allowable value for the test to be considered a PASS. If the measured value is higher than the high limit the test is considered a FAIL.

If not already in PROGRAM mode:

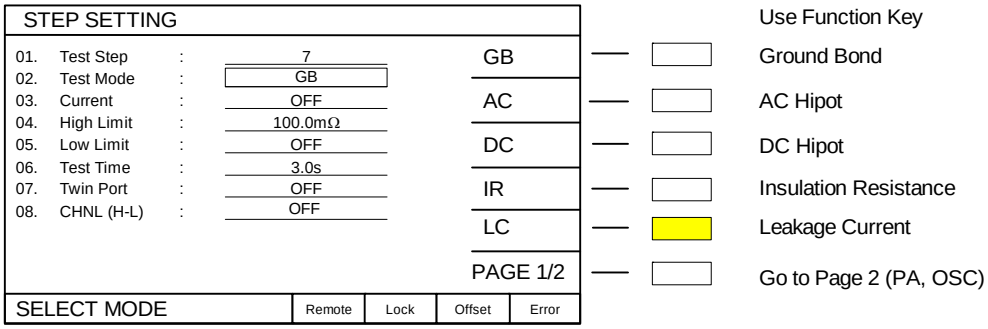
Press [MENU] to access the PROGRAM menu
Press the function key [PROGRAM]

If continuing example:

* Press the function key [UP] to select Step # = 7



Press DOWN arrow [⇓]

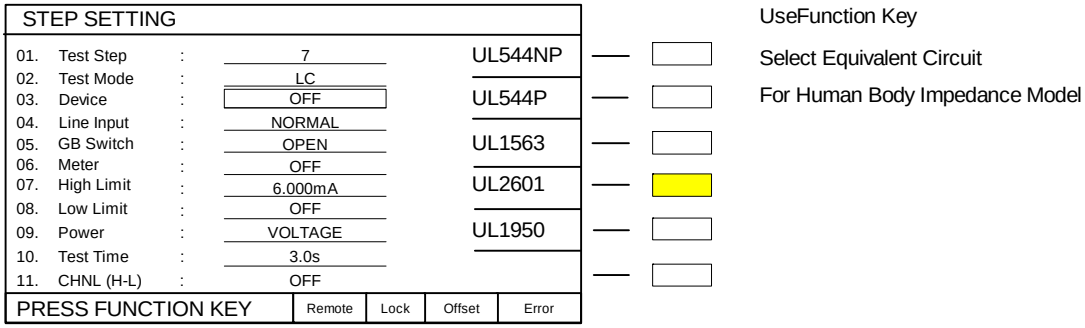


Press the function key [LC] to select mode = Leakage Current

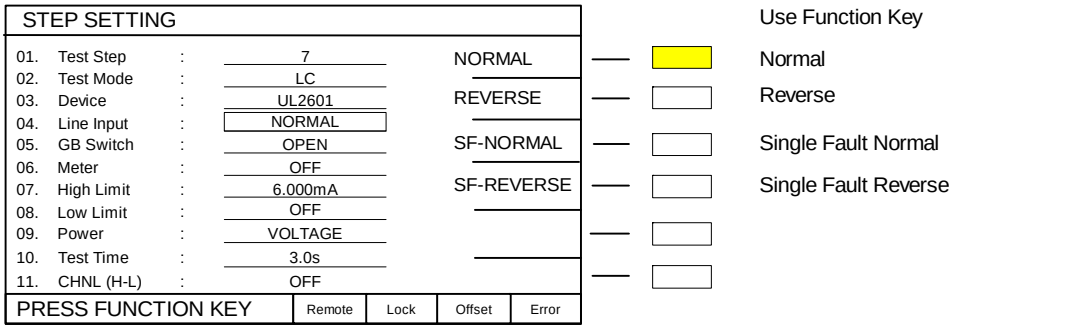
Continued on next page.

LC Programming – continued from last page

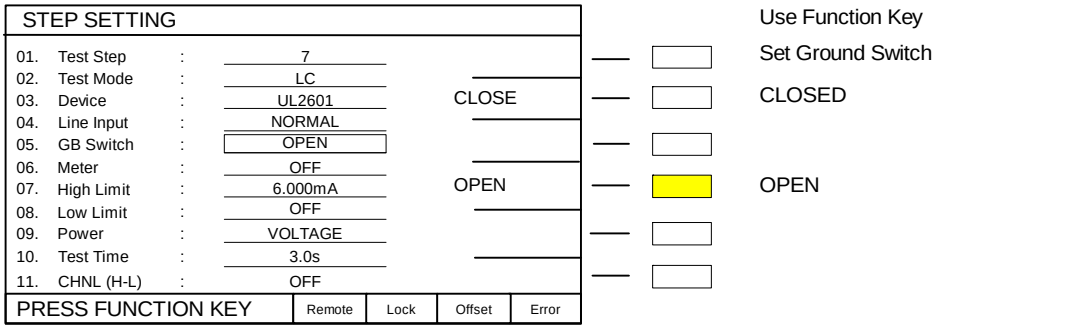
Press DOWN arrow [⇓]



Press the function key [UL2601] to select device = UL2601 body model
Press DOWN arrow [⇓]



Press the function key [NORMAL] to select line input = Normal
Press DOWN arrow [⇓]

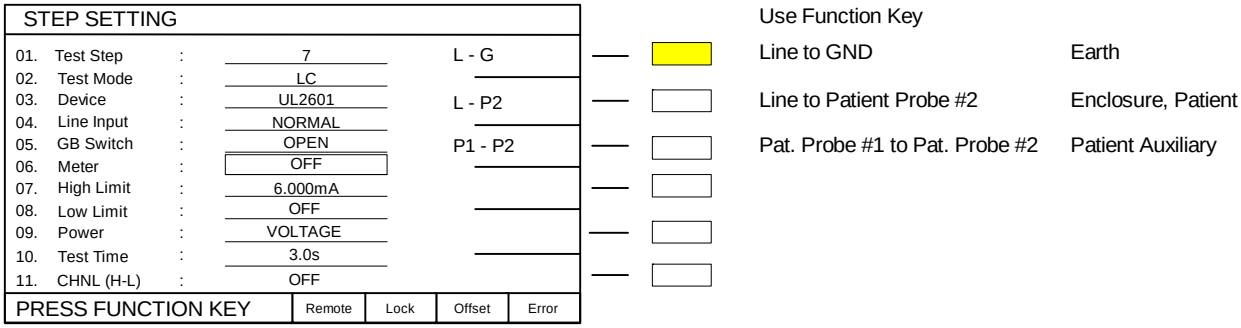


Press the function key [OPEN] to set the Ground Switch = OPEN

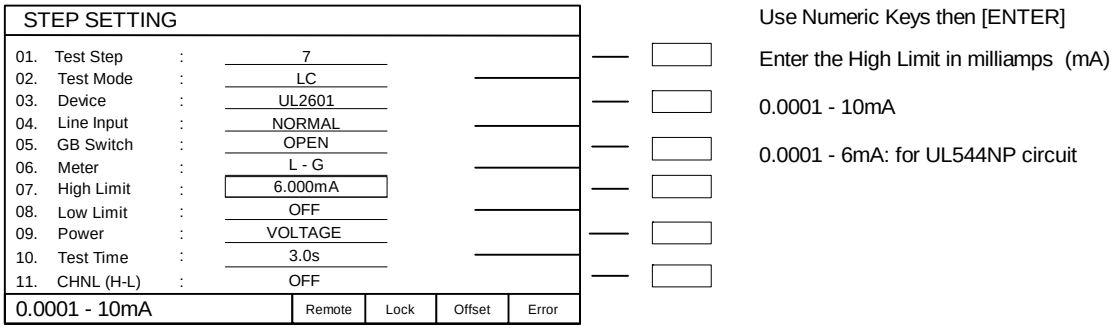
Continued on next page.

LC Programming – continued from last page

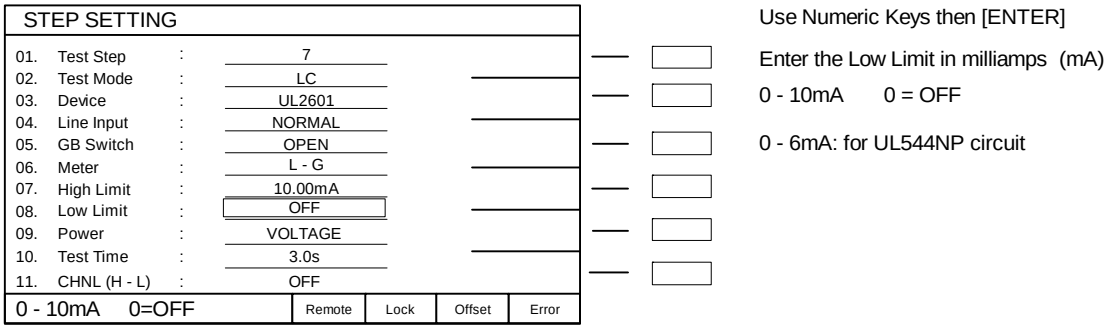
Press DOWN arrow [⇓]



Press the function key [L-G] to set the LC Meter = Line to GND
Press DOWN arrow [⇓]



Press [6][.][0][ENTER] to set high curent limit = 6.000mA
Press DOWN arrow [⇓]

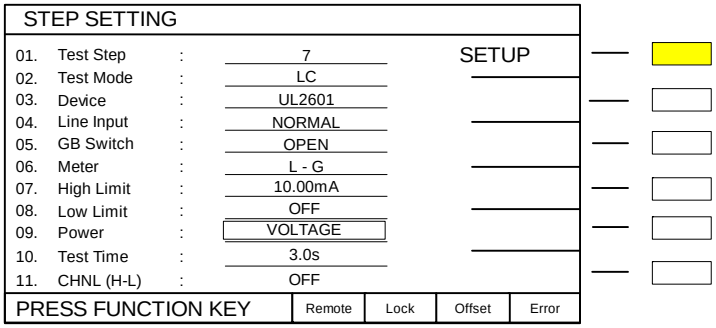


Press [0][ENTER] to set low curent limit = Off

Continued on next page.

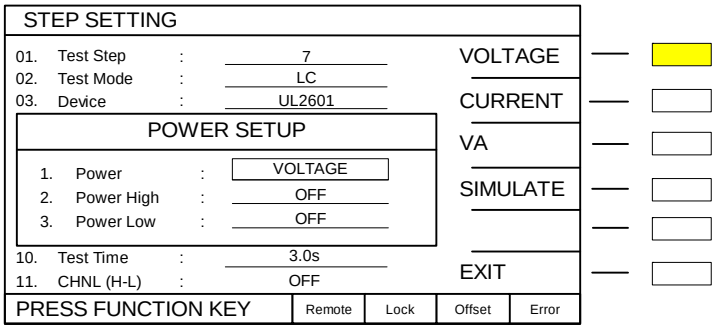
LC Programming – continued from last page

Press DOWN arrow [⇓]



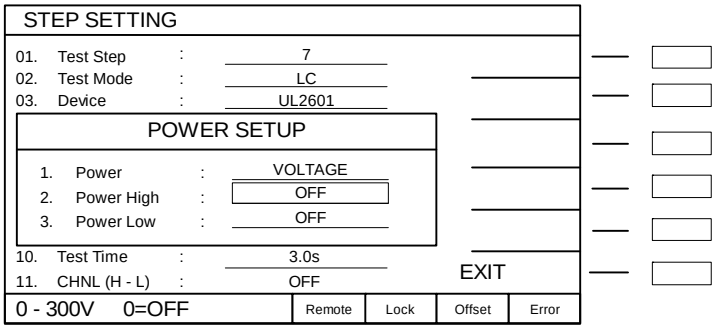
Use Function Key
Setup Power Measurement

Press the function key [SETUP] to setup the power measurement
Press DOWN arrow [⇓]



Use Function Key
Volts (V)
Current (A)
Volt-Amperes (VA)
Use Source: OFF
[SOURCE] if Use Source: ON

Press the function key [VOLTAGE] to set power = Voltage mode
Press DOWN arrow [⇓]



Use Numeric Keys then [ENTER]
Enter the Power High Limit or Target Voltage

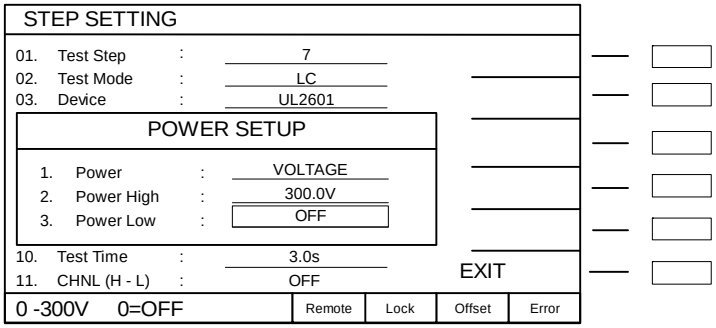
[VOLTAGE]	Power High: 0-300V, 0 = OFF
[CURRENT]	Power High: 0-20A, 0 = OFF
[VA]	Power High: 0-4400V, 0 = OFF
[SIMULATE]	Target-V: 80 - 300V
[SOURCE]	Target-V: 80 - 300V

Press [3][0][0][ENTER] to set high power limit = 300V

Continued on next page.

LC Programming – continued from last page.

Press DOWN arrow [⇓]



Use Numeric Keys then [ENTER]

Enter the Power Low Limit or Target Frequency

[VOLTAGE] Power Low: 0-300V, 0 = OFF

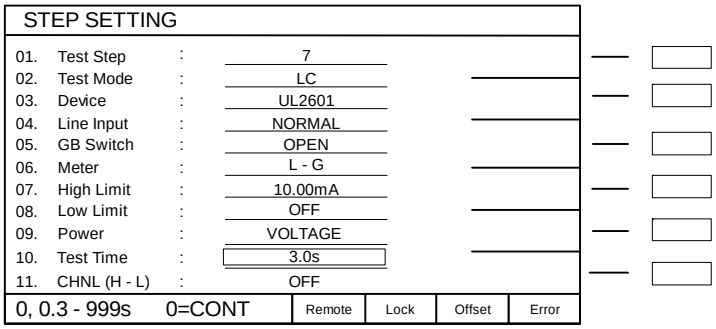
[CURRENT] Power Low: 0-20A, 0 = OFF

[VA] Power Low: 0-4400V, 0 = OFF

[SIMULATE] Not Applicable

[SOURCE] Target-F: 50 - 60Hz

Press [0][ENTER] to set low power limit = Off
Press DOWN arrow [⇓]

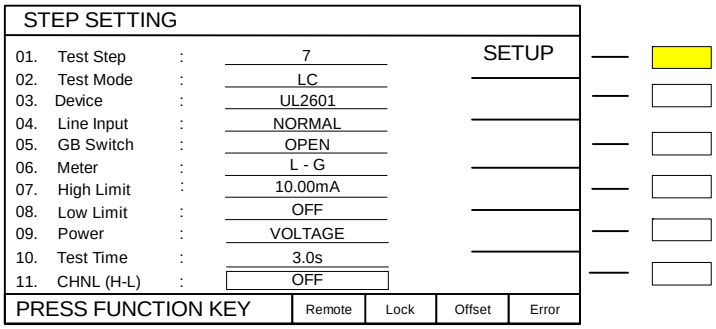


Use Numeric Keys then [ENTER]

Enter theTest Time in seconds (s)

0, 0.3 - 999s 0 =Continuous

Press [3][.][0][ENTER] to set test time = 3.0s
Press DOWN arrow [⇓]
Display reads: "11. CHNL (H-L) : OFF"



Use Function Key

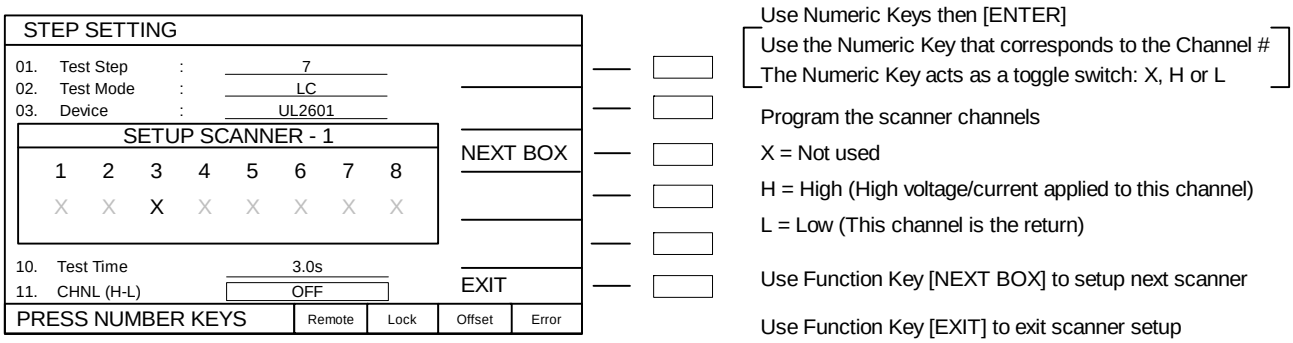
Enter setup menu for scanner(s)

Press the function key [SETUP] to enter scanner setup menu

Continued on next page.

LC Programming – continued from last page.

Scanner #1 is the internal 6000-07 Hipot/Leakage Current Scanner. In LC mode, Channels 1 and 3 are available on Scanner #1. CH1 is used to provide the voltage to the DUT to power it on. CH3 can be set to L or X.



Press [3] once to set Channel 3 to L (Low)
Press the function key [EXIT] to return to LC program menu.
Press DOWN arrow [⇓]
The backlit box is now again at the top of the list adjacent to "Test Step: 7 ".

The 7-step example is complete.
Press [MENU] to exit program mode.
Set Preset (¶2.6)
Perform Offset (¶2.7.1)
Perform Get Cs (¶2.7.2)
Press [MEMORY] then [STORE].
Press DOWN arrow [⇓] to move backlit box to selected location (1-100).
Press [ENTER]
Use numeric keys to give memory location a name (up to 13 alpha-numeric characters).
Complete memory instructions are contained in ¶ 2.5
Press [ENTER] when finished.
Press [MENU] then [TEST].

2.4.7.1 Measurement Equipment

A critical specification for IEC60601-1 standard safety testing is the actual measurement device used in the testing. IEC60601-1 requires the use of a true RMS multi-meter with a very specific load. The load simulates the impedance of the human body. Figure 2-8 illustrates the IEC60601-1 required test load.

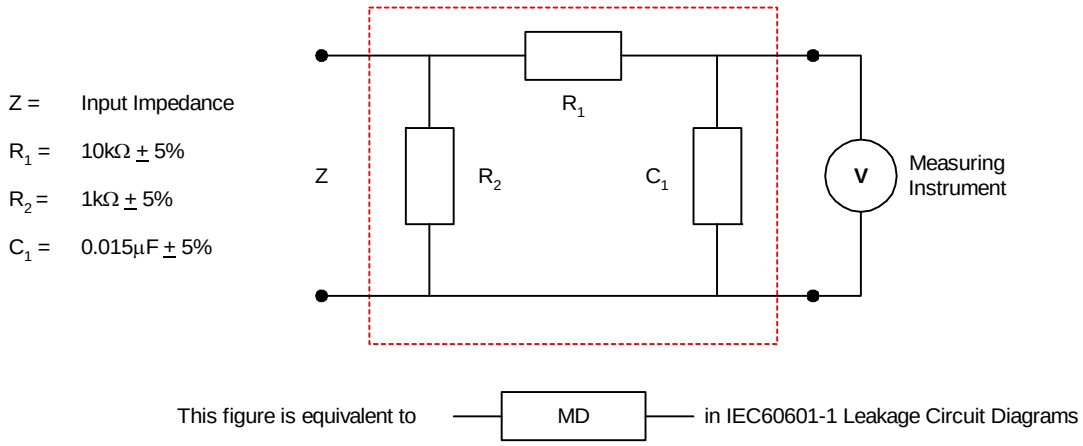


Figure 2-8: Required Test Load

Other Product Safety Standards have a similar circuit that models the impedance of the human body as illustrated in Figure 2-9.

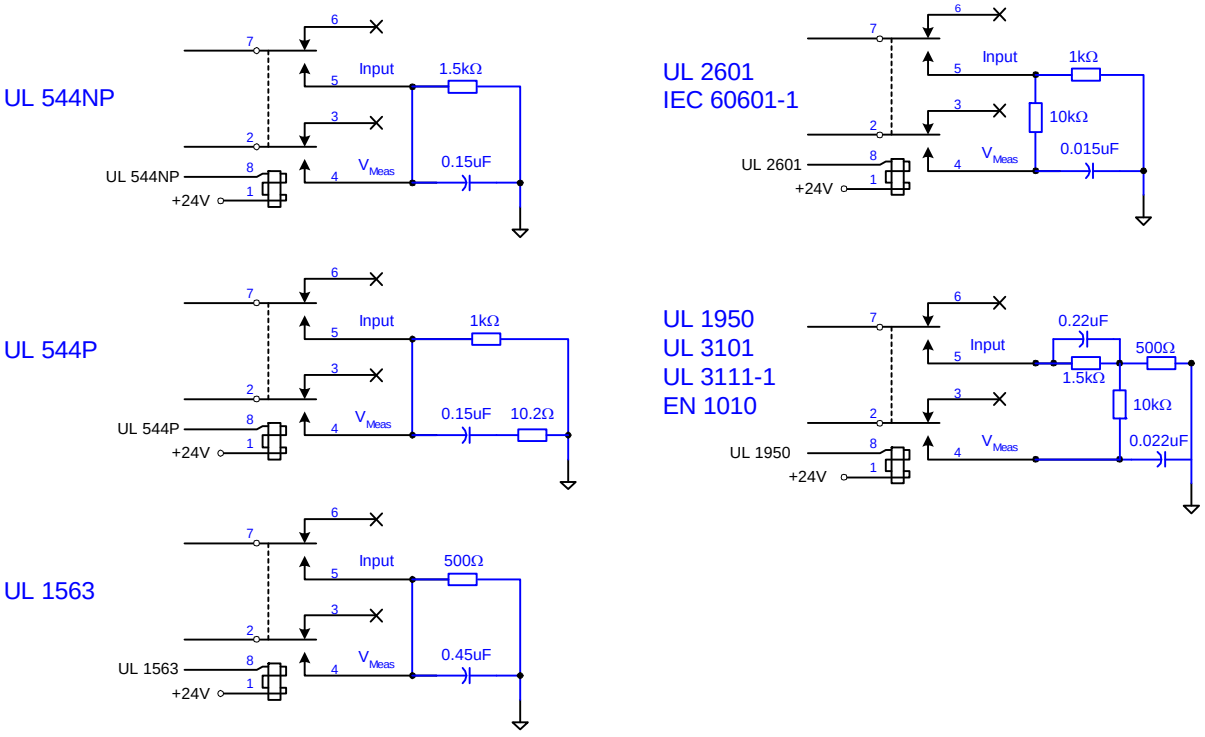


Figure 2-9: Circuit Models for Impedance of Human Body

G6100 Plus Leakage Current Tests

The Guardian 6100 Plus Medical Safety Analyzer measures Earth Line Leakage, Enclosure Leakage, Patient Line Leakage and Patient Auxiliary Leakage Current. The instrument simulates the human body models listed in Table 2-8. The test modes and other programming parameters are also listed in Table 2-8. The Earth LC Test is the sum of all leakages of current in the DUT (device under test). The test measures the current flowing back to Earth Ground through the ground conductor of the line (power) cord.

Table 2-8: 6100 LC Test Parameters

Device	UL544NP, UL544P, UL1563, UL2601, UL1950				
Line Input	Normal, Reverse, Single-Fault Normal, Single-Fault Reverse				
GB Switch	Open, Closed				
Meter	L – G, L – P2, P1 – P2				
High Limit	0.0001-10mA*				
Low Limit	0 - 10mA*, 0=OFF				
Power	VOLTAGE	CURRENT	VA	SIMULATE	SOURCE
Power High	0 – 300V	0 – 20A	0 – 4400 VA	80 – 300V	80 – 300V
Power Low	0 – 300V	0 – 20A	0 – 4400 VA	N/A	50-60Hz

*6mA current limit for UL544NP circuit model

Figure 2-12a through 2-15a illustrate the IEC 60601-1 circuit drawings for Earth, Enclosure, Patient and Patient Auxiliary Leakage Current and contain multiple abbreviations. These abbreviations used in the IEC circuit diagrams are listed herein.

FE			Functional Earth
PE			Protective Earth
MD			Measuring Device
S_1	S_2	S_3	Single pole switch simulates the interruption of power supply conductor
S_5	S_9		Commutator switch reverses polarity of MAINS voltage
S_8			Single pole switch simulates interruption of single PE conductor
S_{10}	S_{11}		Switches to connect FE terminal to earthed point of measuring supply system
S_{12}			Switch to connect F-type Appied Part to earthed point of measuring supply system
S_{13}			Switch to connect earth to metal Accessible Part that is not an Applied Part or PE
T_1	T_2		1-, 2- or polyphase isolation transformers
V_1	V_2		Voltmeter including rms value
P_1			Socket, plug or terminal for supply connection of medical electrical equipment
P_2			Socket, plug or terminal for connection to other equipment in a medical electrical system

-------- Optional Connection

① Medical electrical equipment enclosure

② Separate power supply

③ SIP/SOP (medical device I/O jacks other than patient leads)

④ Internal electrical power source

⑤ Patient Circuit (medical device)

⑥ Metal Accessible Part: not an Applied Part nor Protectively Earthed

Figure 2-10: IEC 60601-1 Abbreviations

Leakage Current – Connection Using In-Rush Protection

When using the Guardian 6100 Plus with a device that may have high in-rush current the isolation transformer should be connected using In-Rush Protectors as shown in Figure 2.11.

The In-Rush Protector (QuadTech part number 800184) is a standard accessory included with the 6100 Plus instrument. It includes a quantity of two protectors. These should be inserted in series between the isolation transformer power output leads and the L-IN and N-IN connections of the G6100 Plus. **These protectors are applicable to the connections shown in Figures 2-12b, 2-13b, 2-14b and 2-15b.**

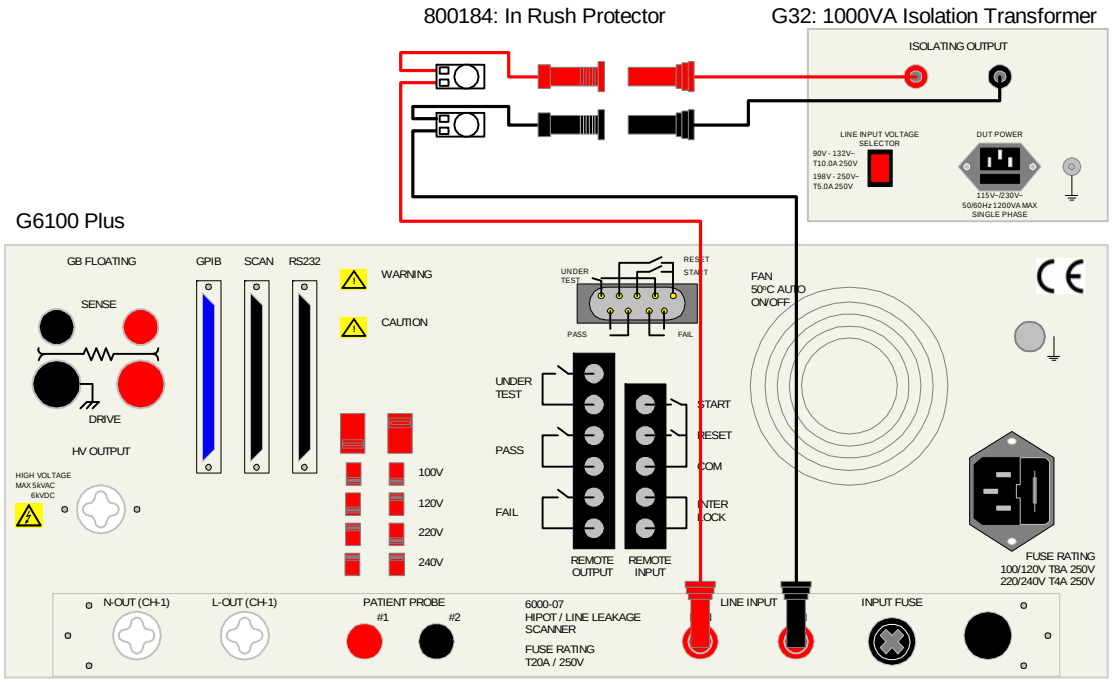


Figure 2-11: Connection for Leakage Current Measurements Using In-Rush Protection

2.4.7.2 Earth (Line) Leakage

Earth leakage current test measures the leakage current flowing back through the ground conductor of the power cord through an impedance that simulates the impedance of the human body. Figure 2-12a shows the circuit connections. This is basically the total leakage current from protectively earthed parts of the medical device.

The Guardian 6100 Plus can perform this test by just plugging the medical device into the G30 corded product adapter. The tests can be performed with any of 4 different mains conditions. These conditions are:

Normal Mains (S5 DOWN position)
Reverse Mains (Hot and Neutral reversed) (S5 UP position, as shown)
Single Fault – Normal (Neutral S1 open & S5 DOWN position)
Single Fault – Reverse (Hot and Neutral reversed with Neutral S1 open)

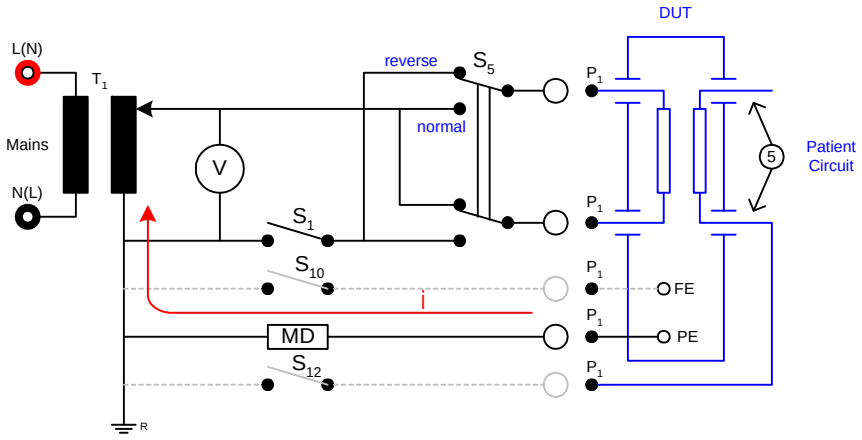


Figure 2-12a: Earth Leakage with or without Applied Part
(Figure 12 of 60601-1 © IEC 2000)

Earth Leakage: Connection to DUT

Figure 2-12b illustrates the connection of the Guardian 6100 Plus for an Earth Leakage Current test. Connect the G32 Isolation Transformer to the 6000-07 LINE INPUT terminals (L-IN and N-IN). Connect the black leads of the G30 Corded Product Adapter to the black (low) SENSE and DRIVE "Optional Rear Output Terminals" of the G6100. Connect the red leads of the G30 to the white L-OUT and N-OUT terminals on the 6000-05. Connect the G15 red lead between the red (high) SENSE and DRIVE terminals and PE (protective earth) on the DUT. Plug the DUT into the G30 Corded Product Adapter.

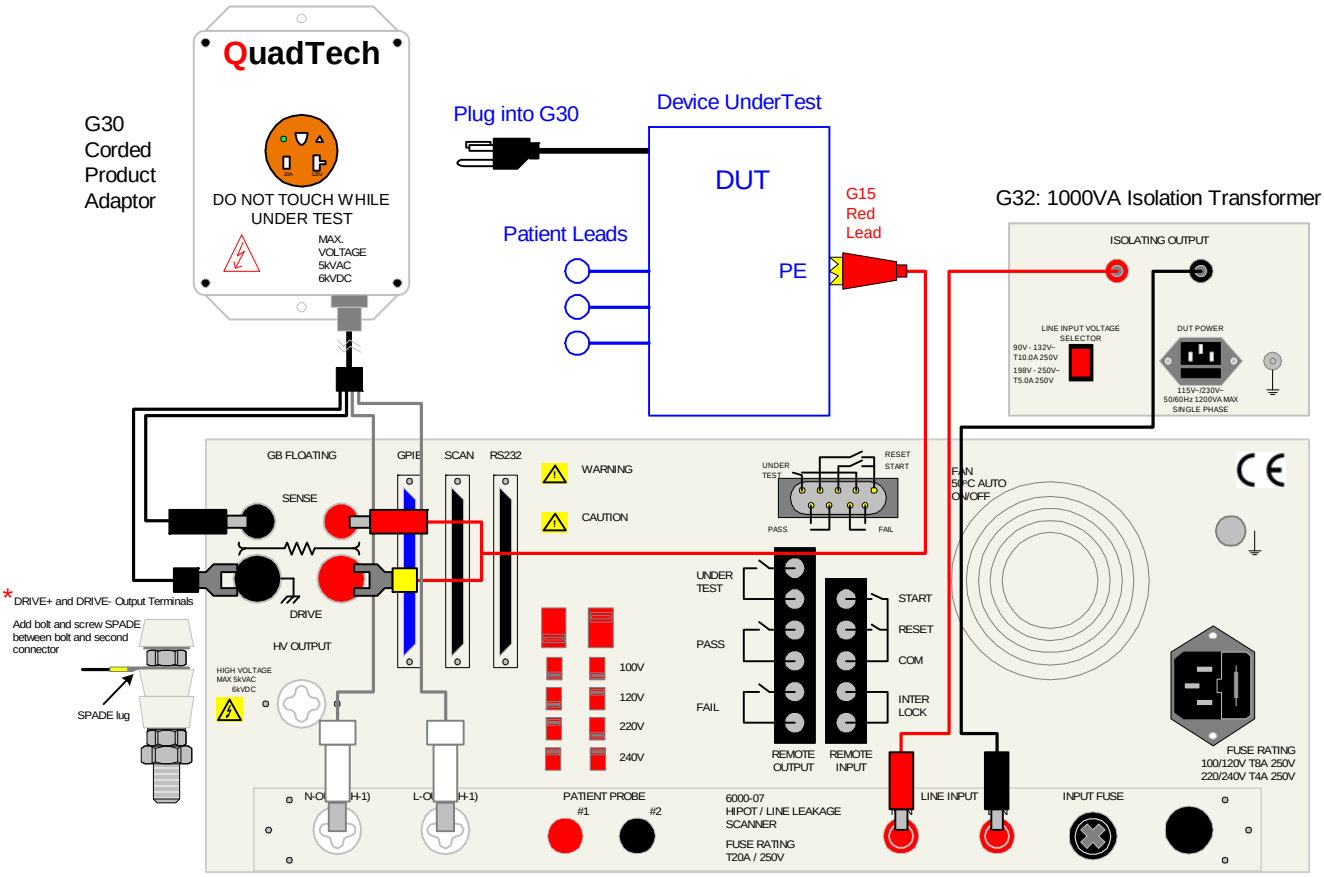


Figure 2-12b: Earth Leakage Test using Guardian 6100 Plus

NOTE

For High Current Ground Bond Testing, make the connection to the DRIVE+ and DRIVE- terminals with the spade lug behind the nut. Use the Bushing Driver Tool included to secure the nut as shown in Figure 2-12b.

NOTE

The L-IN and N-IN inputs require a fully isolated voltage source. The QuadTech G31 or G32 Isolation Transformers are highly recommended although other "isolated" voltage sources can be used.

2.4.7.3 Enclosure (Touch/Chassis) Leakage

Current flowing from the enclosure or other parts, excluding patient connections, back to ground through an impedance which simulates the impedance of the human body. This is the leakage current that would flow through an individual's body should they "touch" that part of the medical device. Enclosure leakage measurements are required to be performed on parts of the enclosure that are not protectively earthed.

Enclosure leakage current can be measured by connecting P2 on the back of the Guardian 6100 Plus to any parts not protectively earthed. The leakage current is then measured from P2 to earth ground through a human body model. The tests can be performed with any of 4 different mains conditions. These conditions are:

Normal Mains (S5 DOWN position)
Reverse Mains (Hot and Neutral reversed) (S5 UP position, as shown)
Single Fault – Normal (Neural S1 open & S5 DOWN position)
Single Fault – Reverse (Hot and Neutral reversed with Neutral S1 open)

All conditions can be performed with the ground switch S7 open or closed.

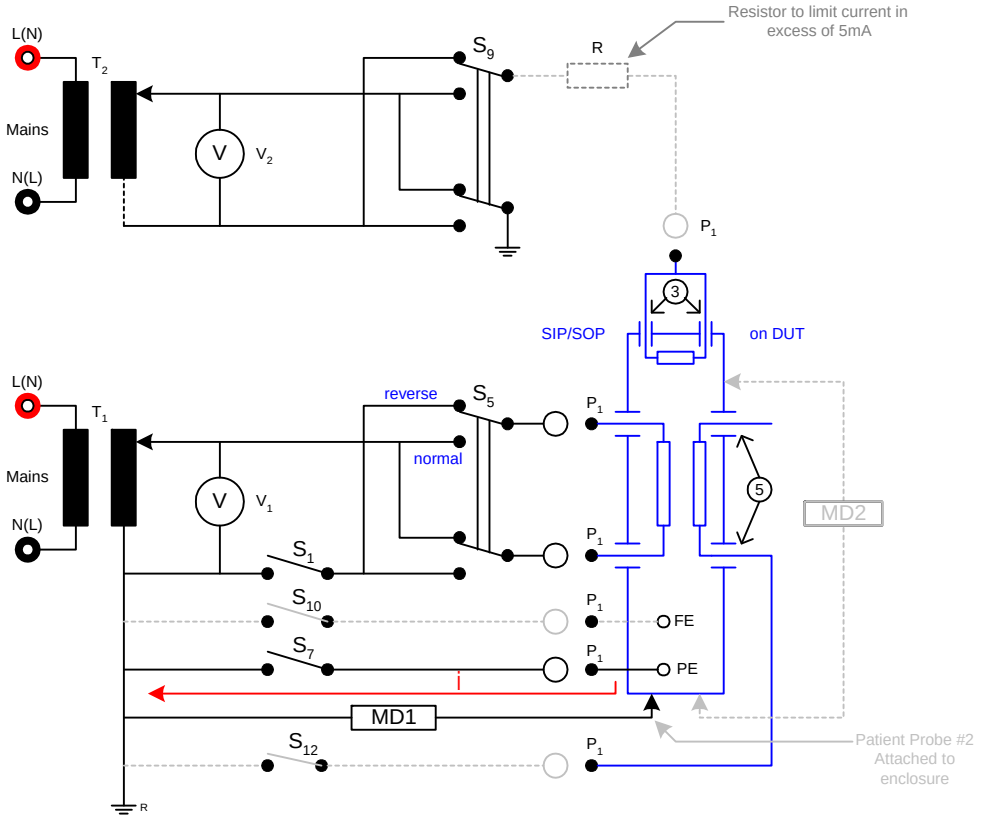


Figure 2-13a: Enclosure (Touch/Chassis) Leakage
(Figure 13 of 60601-1 © IEC 2000)

Enclosure (Touch/Chassis) Leakage: Connection to DUT

Figure 2-13b illustrates the connection of the Guardian 6100 Plus for an Enclosure Leakage Current test. Connect the G32 Isolation Transformer to the 6000-07 LINE INPUT terminals (L-IN and N-IN). Connect the black leads of the G30 Corded Product Adapter to the black (low) SENSE and DRIVE "Optional Rear Output Terminals" of the G6100. Connect the red leads of the G30 to the white L-OUT and N-OUT terminals on the 6000-07. Connect the G15 red lead between the red (high) SENSE and DRIVE terminals of the 6100 Plus and chassis of DUT (that is protective earth, PE, on the DUT). Connect PATIENT PROBE #2 to the enclosure of the DUT. Plug the DUT into the G30 Corded Product Adapter.

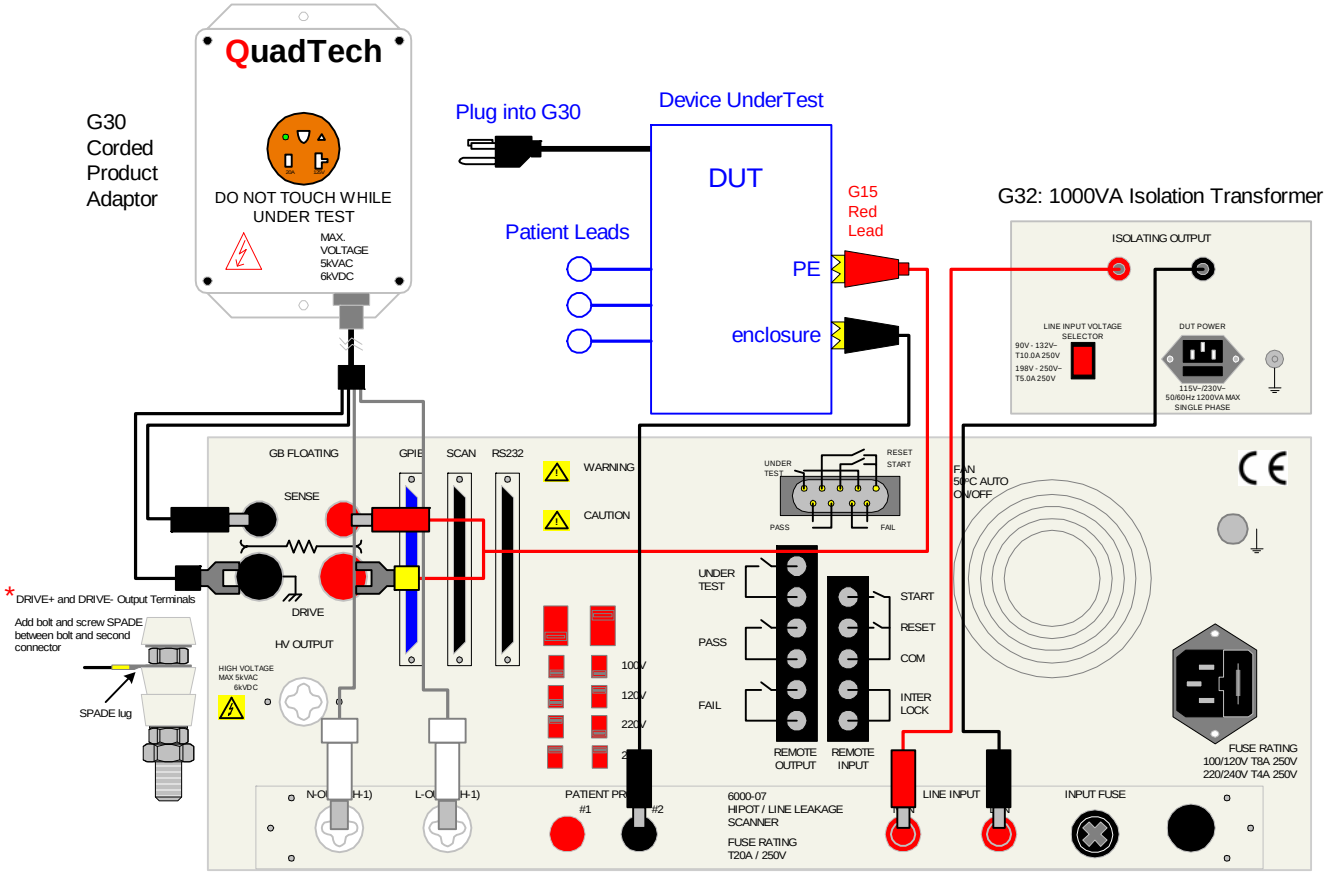


Figure 2-13b: Enclosure Leakage Test using the G6100 Plus

NOTE

For High Current Ground Bond Testing, make the connection to the DRIVE+ and DRIVE- terminals with the spade lug behind the nut. Use the Bushing Driver Tool included to secure the nut as shown in Figure 2-13b.

2.4.7.4 Patient Leakage – Applied Part to Ground

There are two patient connections P1 and P2 on the back of the Guardian 6100 Plus. Patient Leakage can be measured from patient connection P2 to earth ground. This test is performed identical to enclosure leakage current.

The tests can be performed with any of 4 different mains conditions. These conditions are:

Normal Mains (S5 DOWN position)
Reverse Mains (Hot and Neutral reversed) (S5 UP position, as shown)
Single Fault – Normal (Neural S1 open & S5 DOWN position)
Single Fault – Reverse (Hot and Neutral reversed with Neutral S1 open)

All conditions can be performed with the ground switch S7 open or closed.

These measurement can be made under any combination of normal and single fault conditions outlined in Clause 19.2 a). These are same conditions as those outline for earth and enclosure leakage current above. No provisions have be made for testing to Clause 19.2 b) and c) which requires the application of a voltage equal to 110% of the highest rated mains voltage between earth ground and any signal input or output connection not protectively earthed.

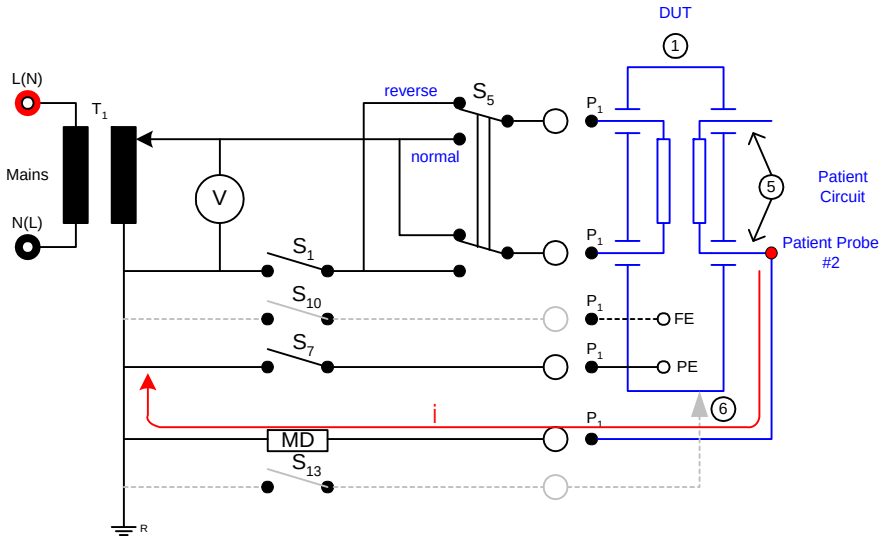


Figure 2-14a: Patient Leakage – Applied Part to Ground
(Figure 14 of 60601-1 © IEC 2000)

Patient Leakage – Applied Part to Ground: Connection to DUT

Figure 2-14b illustrates the connection of the Guardian 6100 Plus, G30, G32 and device under test for the Patient Leakage – Applied Part to Ground test. The external connections are the same as other leakage tests except for the patient connection, P2. The difference is the internal circuit via the programmed test.

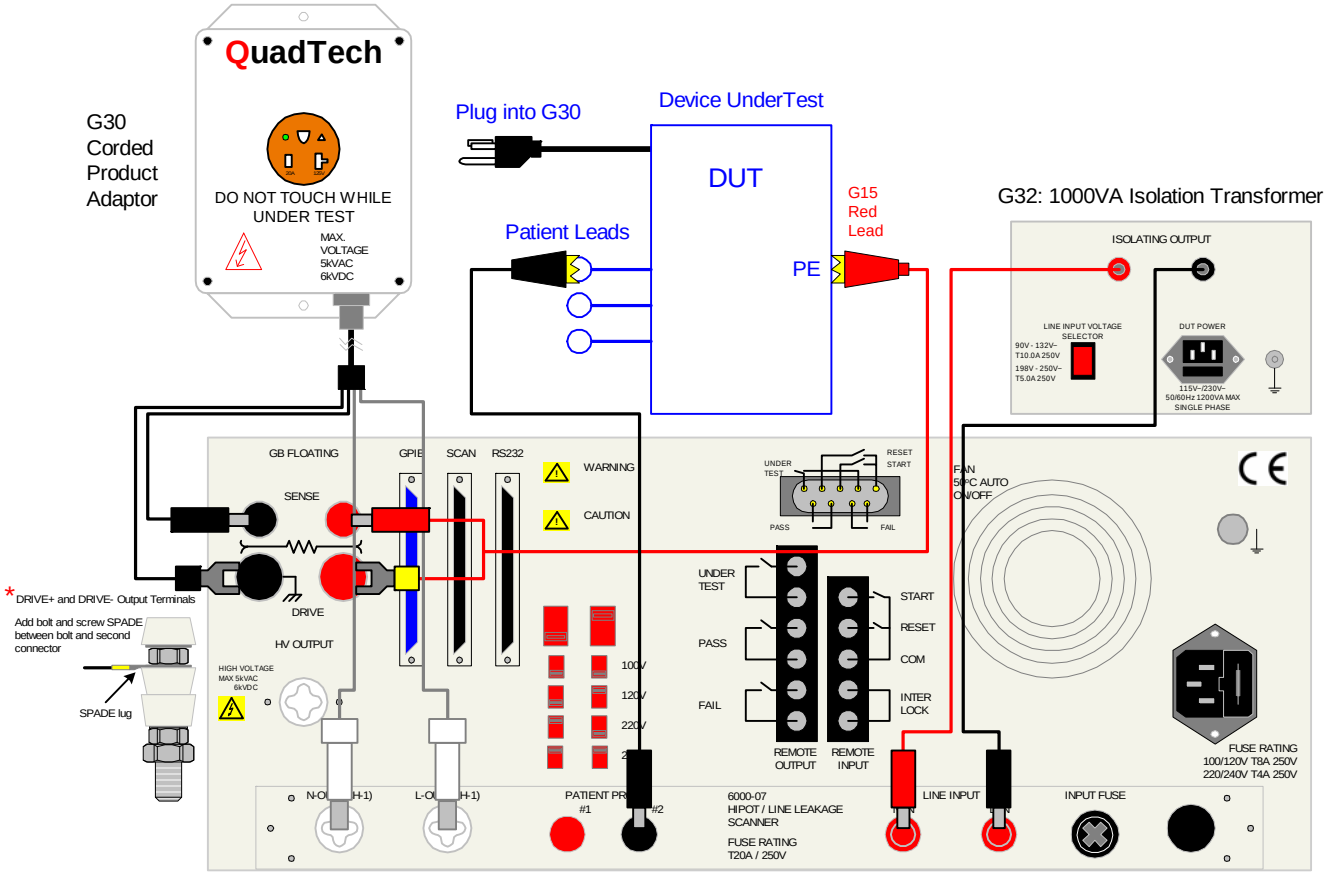


Figure 2-14b: Patient Leakage Applied Part to Ground Test using G6100 Plus

> NOTE
>
> For High Current Ground Bond Testing, make the connection to the DRIVE+ and DRIVE- terminals with the spade lug behind the nut. Use the Bushing Driver Tool included to secure the nut as shown in Figure 2-14b.

2.4.7.5 Patient Auxiliary Leakage

The IEC 60601-1 measuring circuit for the patient auxiliary current test is illustrated in Figure 2-15a. Patient Auxiliary Current can also be measured from patient connection P1 to all other patient connections P2.

The tests can be performed with any of 4 different mains conditions. These conditions are:

Normal Mains (S5 DOWN position)
Reverse Mains (Hot and Neutral reversed) (S5 UP position, as shown)
Single Fault – Normal (Neural S1 open & S5 DOWN position)
Single Fault – Reverse (Hot and Neutral reversed with Neutral S1 open)

All conditions can be performed with the ground switch S7 open or closed.

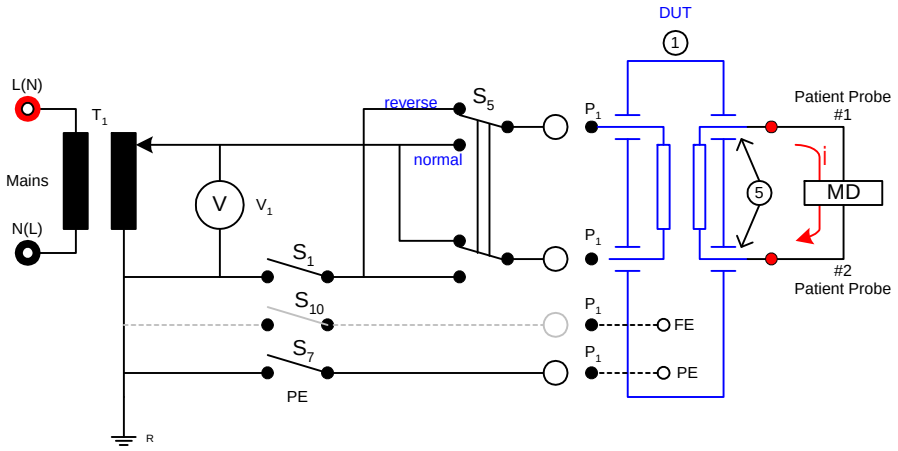


Figure 2-15a: Patient Auxiliary Current
(Figure 17 of 60601-1 © IEC 2000)

Patient Auxiliary Leakage: Connection to DUT

Figure 2-15b illustrates the connections between the Guardian 6100 Plus, G30 corded product adapter, G32 isolation transformer and device under test for a Patient Auxiliary Leakage current test.

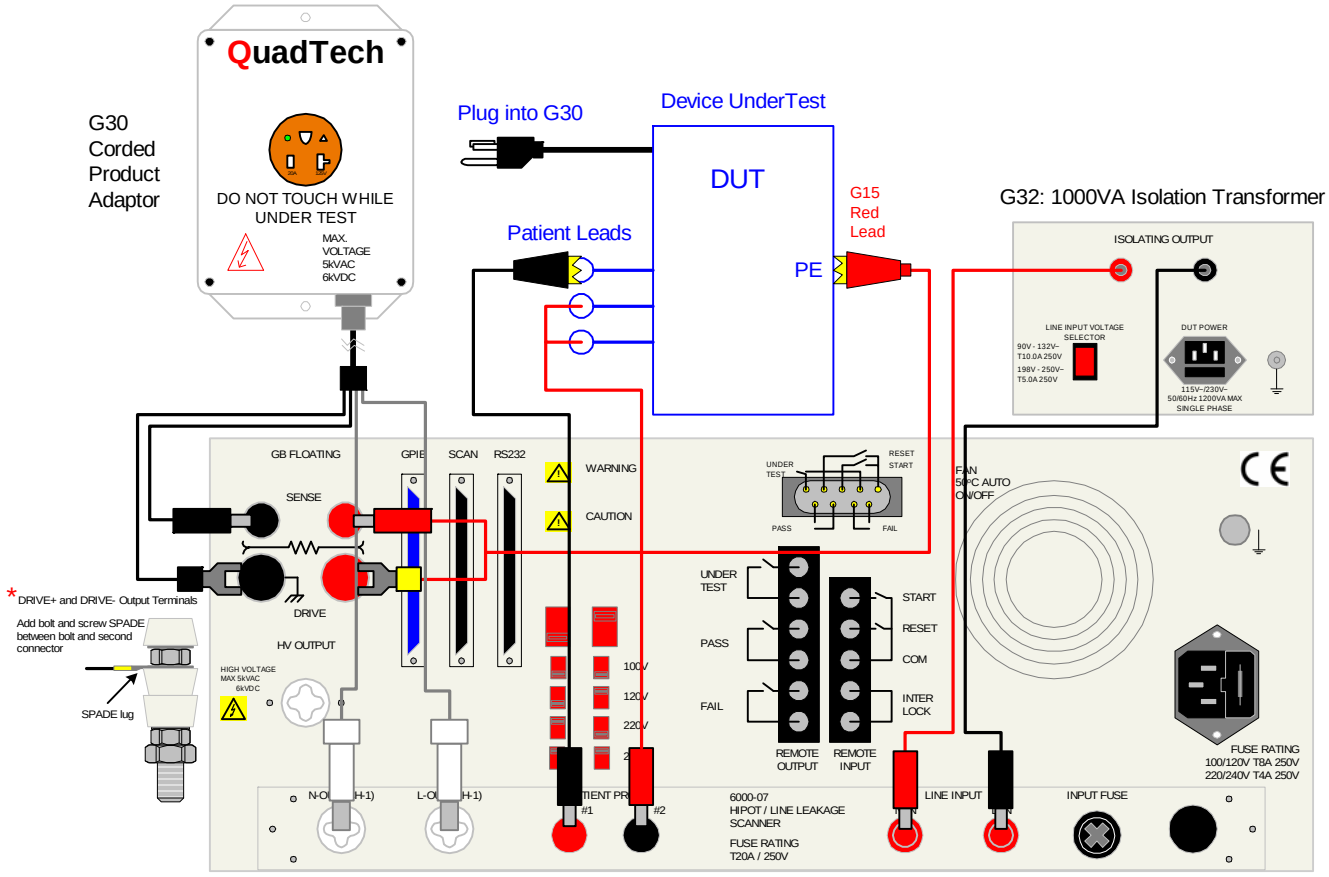


Figure 2-15b: Patient Auxiliary Leakage Test using the G6100 Plus

NOTE

For High Current Ground Bond Testing, make the connection to the DRIVE+ and DRIVE- terminals with the spade lug behind the nut. Use the Bushing Driver Tool included to secure the nut as shown in Figure 2-15b.

2.4.8 Programming a Multi-Step Test

A total of 100 tests can be programmed and each test can consist of 1 to 50 steps in sequence. Each step may be programmed for any available function (GB, AC, DC, IR, LC, PA or OSC) with programmed test conditions independent from the other step.

Contained in this paragraph are the text instructions to program the example 7-step test as shown in Table 2-5 in ¶ 2.4. For this example, the scanner channels have been set to OFF except for LC mode. Instructions to save this example are given at the conclusion of this section. Store and Recall instructions are detailed in paragraph 2.5.

Press the function key [UP] or [DOWN] to select Step # = 1
Press DOWN arrow [⇓]
Press the function key [GB] to select mode = Ground Bond
Press DOWN arrow [⇓]
Press [3][0][ENTER] to set current = 30A
Press DOWN arrow [⇓]
Press [1][0][0][ENTER] to set high limit = 100mΩ
Press DOWN arrow [⇓]
Press [0][ENTER] to set low limt = OFF
Press DOWN arrow [⇓]
Press [3][.][0] to set the test time = 3.0 seconds

Press DOWN arrow [⇓]
Press the function key [OFF] to perform GB and AC seperately
Press DOWN arrow [⇓]
Display reads: "8. CHNL (H-L) : OFF"
Press DOWN arrow [⇓]
The backlit box is now again at the top of the list adjacent to "Test Step: [1]".
Press the function key [UP] to select Step # = 2
Press DOWN arrow [⇓]
Press the function key [PAGE1/2] then [OSC] to select mode = Open/Short Circuit

Press DOWN arrow [⇓]
Press [5][0][ENTER] to set the Open Check = 50%
Press DOWN arrow [⇓]
Press [3][0][0][ENTER] to set the Short Check = 300%
Press DOWN arrow [⇓]
Display reads: "5. CHNL (H-L) : OFF"
Press DOWN arrow [⇓]
The backlit box is now again at the top of the list adjacent to "Test Step: [2]".
Press the function key [UP] to select Step # = 3
Press DOWN arrow [⇓]

Press the function key [AC] to select mode = AC Hipot
Press DOWN arrow [⇓]
Press [1][.][5][0][0][ENTER] to set voltage = 1.500kV (1500V)
Press DOWN arrow [⇓]
Press [0][.][5][0][0][ENTER] to set the high current limit = 0.500mA
Press DOWN arrow [⇓]
Press [0][ENTER] to set low current limit = OFF
Press DOWN arrow [⇓]
Press [0][ENTER] to set arc current limit = OFF
Press DOWN arrow [⇓]

Press the function key [3 -230 kHz] to set arc filter frequency = 3 – 230kHz
Press DOWN arrow [⇓]
Press [3][.][0][ENTER] to set test time = 3.0s
Press DOWN arrow [⇓]
Press [0][ENTER] to set ramp time = OFF
Press DOWN arrow [⇓]
Display reads: "10. CHNL (H-L) : OFF"
Press DOWN arrow [⇓] The backlit box is now again at the top of the list adjacent to "Test Step: ___3___ ".
Press the function key [UP] to select Step # = 4

Press DOWN arrow [⇓]
Press the function key [PAGE1/2] then [PA] to select mode = Pause
Press DOWN arrow [⇓]
Enter Pause Message: "CHANGE LEAD"
Press DOWN arrow [⇓]
Press the function key [OFF] to set Under Test relay = OFF
Press DOWN arrow [⇓] The backlit box is now again at the top of the list adjacent to "Test Step: ___4___ ".
Press the function key [UP] to select Step # = 5
Press DOWN arrow [⇓]

Press the function key [DC] to select mode = DC Hipot
Press DOWN arrow [⇓]
Press [2][.][4][0][0][ENTER] to set voltage = 2.400kV
Press DOWN arrow [⇓]
Press [0][.][5][0][0][ENTER] to set high current limit = 0.500mA
Press DOWN arrow [⇓]
Press [0][ENTER] to set low current limit = OFF
Press DOWN arrow [⇓]
Press [3][.][0][ENTER] to set dwell time = 3.0s

Press DOWN arrow [⇓]
Press [0][ENTER] to set arc current limit = OFF
Press DOWN arrow [⇓]

Press the function key [3 -230 kHz] to set arc filter frequency = 3 – 230kHz
Press DOWN arrow [⇓]
Press [3][.][0][ENTER] to set test time = 3.0s
Press DOWN arrow [⇓]
Press [3][.][0][ENTER] to set ramp time = 3.0s
Press DOWN arrow [⇓]
Display reads: "11. CHNL (H-L) : OFF"
Press DOWN arrow [⇓] The backlit box is now again at the top of the list adjacent to "Test Step: [5] ".

Press the function key [UP] to select Step # = 6
Press DOWN arrow [⇓]
Press the function key [IR] to select mode = Insulation Resistance
Press DOWN arrow [⇓]
Press [1][.][0][ENTER] to set voltage = 1.000kV
Press DOWN arrow [⇓]
Press [1][0][0][0][0][ENTER] to set low resistance limit = 10,000MΩ
Press DOWN arrow [⇓]
Press [0][ENTER] to set high resistance limit = OFF

Press DOWN arrow [⇓]
Press [3][.][0][ENTER] to set test time = 3.0s
Press DOWN arrow [⇓]
Press [3][.][0][ENTER] to set ramp time = 3.0s
Press DOWN arrow [⇓] Display reads: "8. CHNL (H-L) : OFF"
Press DOWN arrow [⇓] The backlit box is now again at the top of the list adjacent to "Test Step: [6] ".
Press the function key [UP] to select Step # = 7
Press DOWN arrow [⇓]
Press the function key [LC] to select mode = Leakage Current
Press DOWN arrow [⇓]

Press the function key [UL2601] to select device = UL2601 body model
Press DOWN arrow [⇓]
Press the function key [NORMAL] to select line input = Normal
Press DOWN arrow [⇓]
Press the function key [OPEN] to select ground switch = Open
Press DOWN arrow [⇓]
Press the function key [L-G] to set meter connection = Line to Ground
Press DOWN arrow [⇓]
Press [1][0][.][0][ENTER] to set high curent limit = 10.00mA

Press DOWN arrow [⇓]
Press [0][ENTER] to set low curent limit = OFF
Press DOWN arrow [⇓]
Press the function key [SETUP] to setup the power measurement

Press the function key [VOLTAGE] to set power = Voltage mode
Press DOWN arrow [⇓]
Press [3][0][0][ENTER] to set high power limit = 300V
Press DOWN arrow [⇓]
Press [0][ENTER] to set low power limit = OFF
Press the function key [EXIT] to exit power setup
Press DOWN arrow [⇓]

Press [3][.][0][ENTER] to set test time = 3.0s
Press DOWN arrow [⇓]
Display reads: "11. CHNL (H-L) : OFF"
Press the function key [SETUP] to enter scanner setup menu
Press [3] once to set Channel 3 to L (Low)
Press the function key [EXIT] to return to LC program menu.
Press DOWN arrow [⇓] The backlit box is now again at the top of the list adjacent to "Test Step: 7 ".

Press [MENU] to exit program mode.
Set Preset (¶2.6)
Perform Offset (¶2.7.1)
Perform Get Cs (¶2.7.2)
Press the function key [MEMORY] The backlit box is adjacent to location 1: "1. (0) : ".
Press DOWN arrow [⇓] to move backlit box to selected location (3 for this example).
Press the function key [STORE]
Use numeric keypad to name memory location (up to 13 alpha-numeric characters).
Press [ENTER] then [NEXT CHAR.] to move cursor to next character.
Name this setup "EXAMPLE".

Press [ENTER] when finished: "3. (_7) : EXAMPLE ".
Message: "STORE? Press ENTER to continue"
Press [ENTER]
Press MENU
Press the function key [TEST]
End of example.

2.5 MEMORY

There are 100 locations in memory and up to 50 test steps may be stored in any one location for a total memory block of 500. There are 10 memory locations listed per page on the display. [NEXT PAGE] will move the backlit box to the top of the next page in memory. The [↑] and [↓] arrows move the backlit box UP and DOWN the displayed page.

To access MEMORY, press the [MENU] function key at the top left hand corner of the keypad and press the function key [MEMORY]. Within MEMORY there are 3 functions: Store, Recall and Delete. Refer to Figure 2-16.

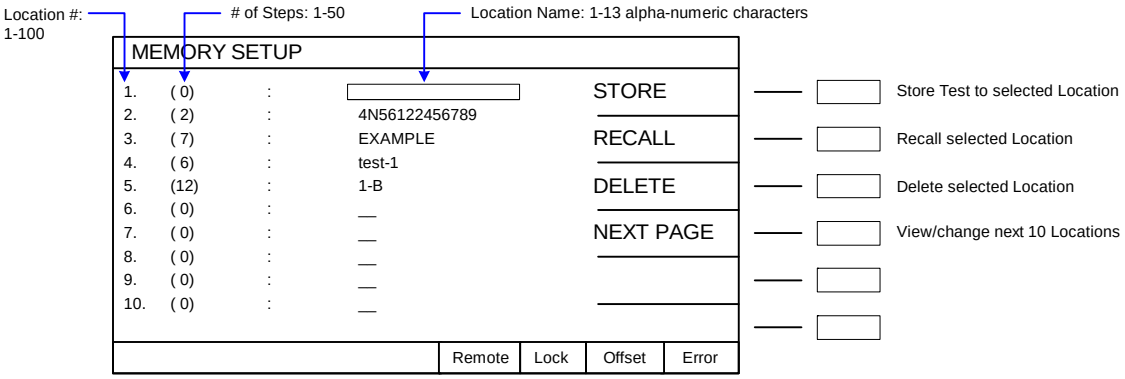


Figure 2-16: MEMORY

To access any of these 3 functions, press the function key that corresponds to the desired parameter.

> Note:
> The [↑] and [↓] arrows move the backlit box UP and DOWN the displayed page.

2.5.1 Storing a Test

> Note:
> Prior to storing a test make sure all PRESET parameters have been set and all steps have been programmed.

The preset values will be stored with the test setup. The Offset and Get Cs functions should be performed, so that the Offset and Get Cs values can also be stored with the test setup. Note however that the Offset and Get Cs values are only valid for the particular connection to DUT and known DUT, respectively. Anytime the test leads, fixture or standard DUT changes, then the Offset and Get Cs functions must be performed again.

To access the STORE function in MAIN MENU, press the function key [MEMORY]. Use the [↑] and [↓] arrows to move the backlit box to the desired memory location (the number in parenthesis will be 0 indicating no steps and the backlit box will be empty) [ ]. Press the function key [STORE]. Name location using alppha-numeric keypad. Press [ENTER] to store the test setup. Press [EXIT] to return to the MAIN MENU.

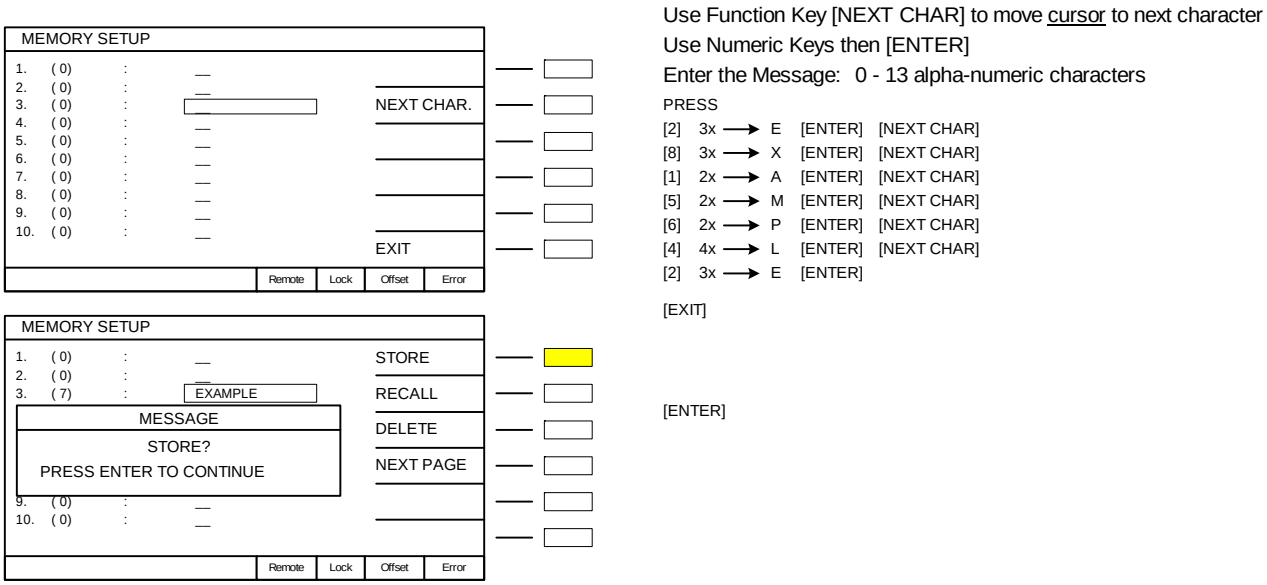


Figure 2-17: STORE Example

2.5.2 Recalling a Test

To access the RECALL function in MAIN MENU, press the function key [MEMORY]. Use the [↑] and [↓] arrows to move the backlit box to the desired memory location (the number in parenthesis will be 1-50 indicating the number of steps and the backlit box may contain the test name) [EXAMPLE]. Press the function key [RECALL]. Press [ENTER] to recall the test setup. Press [EXIT] to return to the MAIN MENU.

2.5.3 Deleting a Test Step

To access the DELETE function in MAIN MENU, press the function key [MEMORY]. Use the [↑] and [↓] arrows to move the backlit box to the desired memory location (the number in parenthesis will be 1-50 indicating the number of steps and the backlit box may contain the test name) [EXAMPLE]. Press the function key [DELETE]. Press [ENTER] to delete the test setup. Press [EXIT] to return to the MAIN MENU.

2.5.4 Clearing Memory

All stored test conditions in instrument memory (100 setups) may be cleared. Caution: all preset and option parameters are cleared as well as all memory locations. All parameters will be reset to default values.

To clear setup memory:

With the instrument in MAIN MENU,
Press the numerical key [4] that corresponds to CALIBRATION. Instrument displays message: "Enter Calibration Password".
Press [8][5][2][4][6] [ENTER] Instrument displays message: "Clear Memory?"
Press function key [YES] to clear all memory.
Press function key [NO] to abort the clear all memory function.
Press [EXIT] to return to MAIN MENU

2.6 PRESET

To access PRESET SETUP, press the [MENU] function key at the top left hand corner of the keypad and press the function key [PRESET]. Within PRESET SETUP there are 12 parameters: Pass Hold, Step Hold, AC Frequency, GB Frequency, IEC-601, GB Voltage, Auto Range, Software AGC, Part No., Lot No., Serial No. and Start Wait. Refer to Figure 2-18.

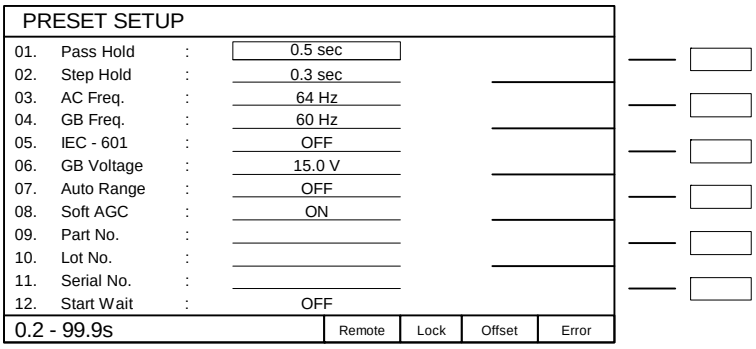


Figure 2-18: PRESET SETUP

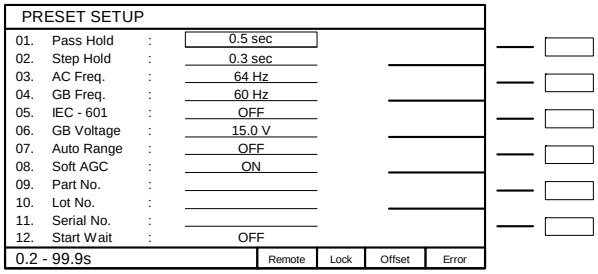
To access any of these 12 parameters, press the [↑] or [↓] arrow on the keypad to move the backlit box to the desired parameter. The status window in the bottom left-hand corner of the display shows the range for the selected parameter. Use the function keys or the numerical keys and [ENTER] to set a PRESET parameter.

Table 2-9: Preset Parameters

Parameter	Range	Default
Pass Hold	0.2 – 99.9s	0.5s
Step Hold	KEY, 0.1 – 99.9s	0.3s
AC Frequency	50 – 600Hz	60Hz
GB Frequency	50/60Hz	60Hz
IEC-601	ON/OFF	OFF
GB Voltage	6.0 – 15.0V	15.0V
Auto Range	ON/OFF	OFF
Software AGC	ON/OFF	ON
Part No.	13 character alpha-numeric string	--
Lot No.	13 character alpha-numeric string	--
Serial No.	13 character alpha-numeric string	--
Start Wait	0, 0.1 – 99.9s	0 (OFF)

2.6.1 Pass Hold

Pass Hold is the amount of time the buzzer will sound after a Pass, as well as how long the pass relay on the Remote I/O will remain closed. To access Pass Hold, press [PRESET] function key in MAIN MENU and then the [↓] or [↑] arrow on the keypad so the backlit box is to the right of Pass Hold. Use the numeric keypad to enter the time the instrument will hold on a PASS result. The Pass Hold range is 0.2 – 99. 9 seconds and the default setting is 0.5s.



2.6.2 Step Hold

When a multi-step test has been programmed, step hold is the time in between each step. When set to KEY, the unit will wait for the START command before continuing to the next step. To access Step Hold, press [PRESET] and then the [↓] or [↑] arrow on the keypad so the backlit box is to the right of Step Hold. Use the function key [KEY] or the numeric keys and [ENTER] to change the time the instrument waits between test steps. The Step Hold range is KEY, 0.1 – 99. 9 seconds and the default setting is 0.3s.

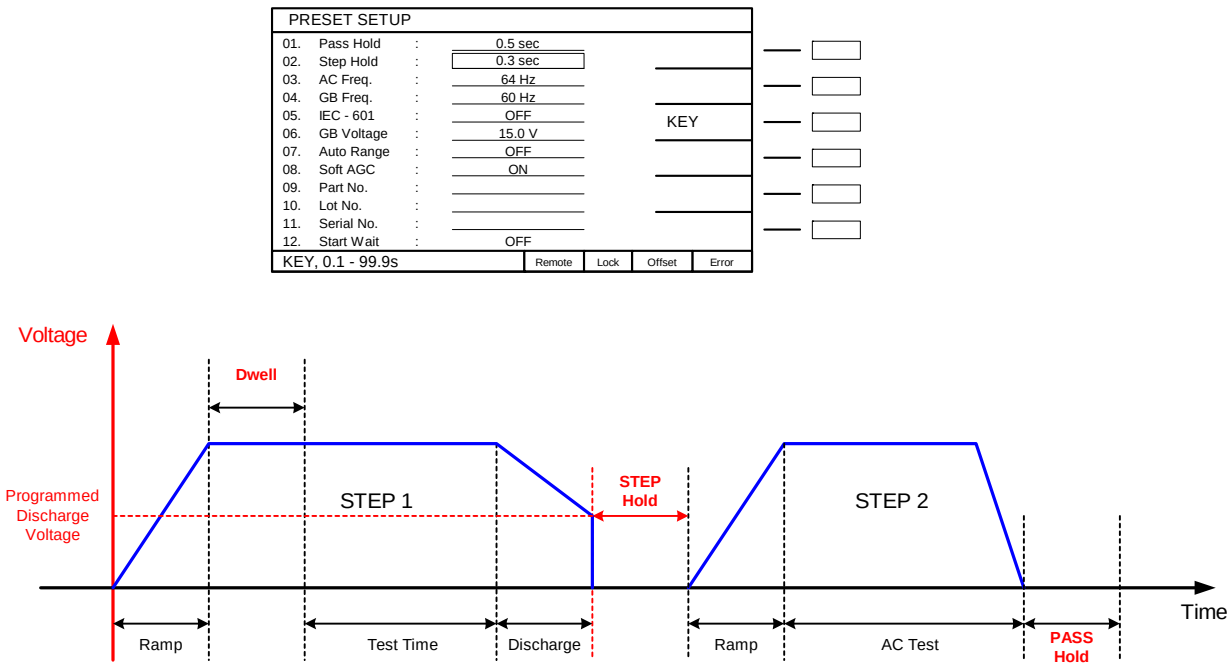
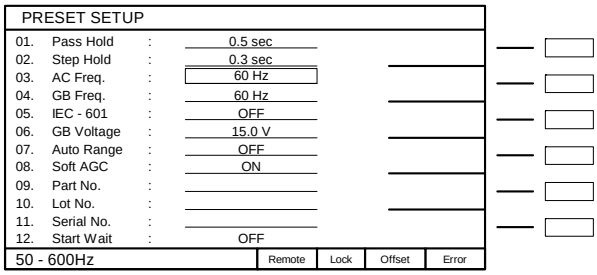


Figure 2-19: Hold Times

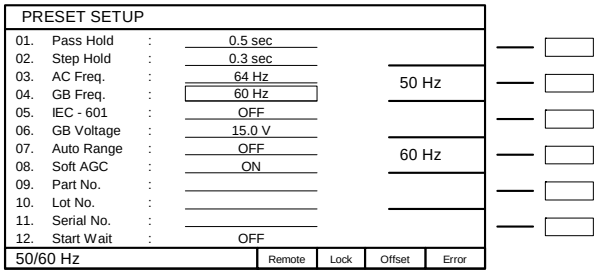
2.6.3 AC Frequency

To access AC Frequency, press [PRESET] and then the [↓] or [↑] arrow on the keypad so the backlit box is to the right of AC Frequency. Use the numerical keys then [ENTER] to enter the frequency in hertz. The range is 50-600Hz and the default setting is 60Hz.



2.6.4 GB Frequency

To access GB Frequency, press [PRESET] and then the [↓] or [↑] arrow on the keypad so the backlit box is to the right of GB Frequency. Use the function key [50Hz] or [60Hz] to select the frequency for the ground bond test in hertz. The range is 50/60Hz and the default setting is 60Hz.



2.6.5 IEC-601

The IEC601-1 feature is applicable to DC hipot only. This test is Insulation Breakdown per IEC60601-1, Clause 20. The G6100 Plus unit will initially apply ½ the programmed test voltage, then gradually apply a linear ramp to the test voltage over the programmed ramp time until the required test voltage is achieved. The G6100 Plus holds the voltage for the programmed test time then ramps back down identical to the ramp up.

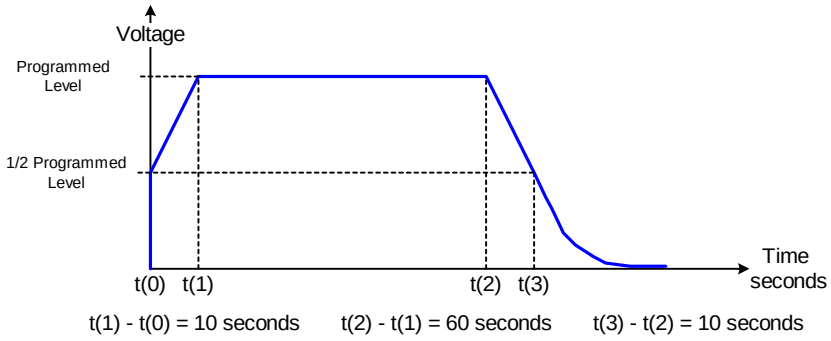
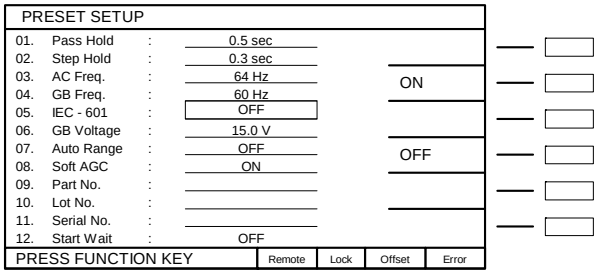


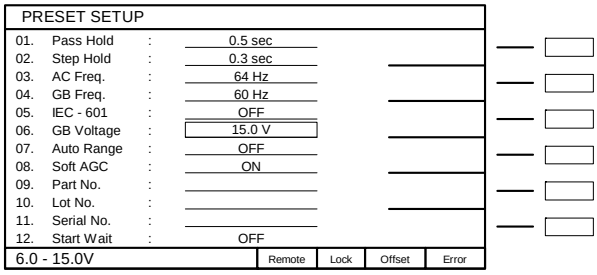
Figure 2-20: 1/2 Programmed Test Voltage

To access IEC-601, press [PRESET] and then the [↓] or [↑] arrow on the keypad so the backlit box is to the right of IEC-601. Use the function key [ON] or [OFF] to enable/disable the IEC-601 function. The default setting is OFF.



2.6.6 GB Voltage

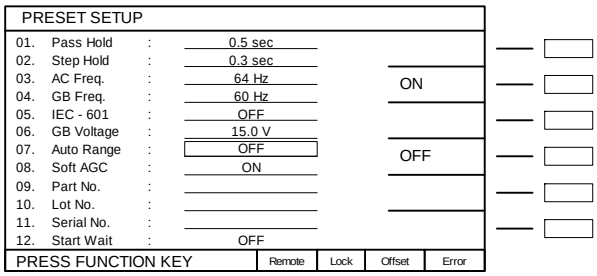
GB Voltage is the open circuit voltage during the ground bond test. To access GB Voltage, press [PRESET] and then the [↓] or [↑] arrow on the keypad so the backlit box is to the right of GB Voltage. Use the numerical keys then [ENTER] to enter the voltage in volts. The range for GB Voltage is 6.0-15.0V and the instrument default value is 15.0V.



2.6.7 Auto Range

In an AC or DC Hipot test, the Auto Range setting permits the use the full scale current range (ON) or using the user programmed maximum current limit (OFF). The low current range (3mA full scale for AC; 300µA for DC) results in increased measurement resolution. Note: setting Auto Range to ON may induce erratic results if the measurement is close to the range limitation.

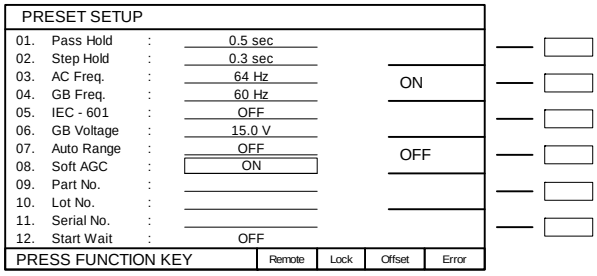
To access Auto Range, press [PRESET] and then the [↓] or [↑] arrow on the keypad so the backlit box is to the right of Auto Range. Use the function key [ON] or [OFF] to turn the source ON or OFF. The default setting is OFF.



2.6.8 Software AGC

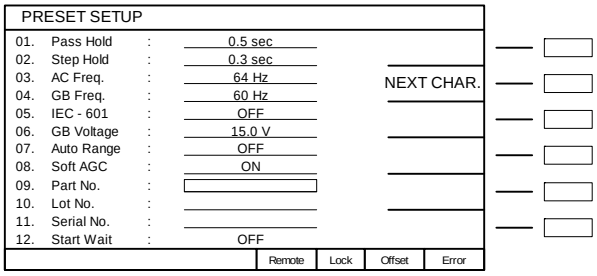
The Software Automatic Gain Control (AGC) setting allows the option of correcting the output voltage (ON). This is may be beneficial when measuring resistors but under special circumstances when measuring large capacitive devices it is best to select Soft. AGC OFF.
Refer to paragraph 2.3.1.4 for additional AGC information.

To access Software AGC, press [PRESET] and then the [↓] or [↑] arrow on the keypad so the backlit box is to the right of Software AGC. Use the function keys [ON] or [OFF] to turn the software automatic gain control ON or OFF. The default setting is ON.



2.6.9 Part No.

The PART NUMBER function allows the operator to assign a part number to the device under test. To access Part No., press [PRESET] and then the [↓] or [↑] arrow on the keypad so the backlit box is to the right of Part No. Use the numerical keys to select first character then use [NEXT CHAR] to move the underscore cursor to the next character. When finished entering the part number string, press [ENTER]. The part number can be made up of 0-13 alpha or numeric characters.



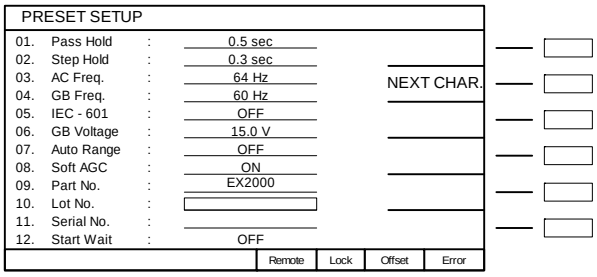
Use Function Key [NEXT CHAR] to move cursor to next character
Use Numeric Keys then [ENTER]
Enter the Message: 0 - 13 alpha-numeric characters

PRESS
[2] 3x → E [ENTER] [NEXT CHAR]
[8] 3x → X [ENTER] [NEXT CHAR]
[2] 1x → 2 [ENTER] [NEXT CHAR]
[0] 1x → 0 [ENTER] [NEXT CHAR]
[0] 1x → 0 [ENTER] [NEXT CHAR]
[0] 1x → 0 [ENTER] [NEXT CHAR]
[ENTER]
[EXIT]

Example Part No.: EX2000

2.6.10 Lot No.

The LOT NUMBER function allows the operator to assign a lot number to the device under test. To access Lot No., press [PRESET] and then the [↓] or [↑] arrow on the keypad so the backlit box is to the right of Lot No. Use the numerical keys to select first character then use [NEXT CHAR] to move the underscore cursor to the next character. When finished entering the lot number string, press [ENTER]. The lot number can be made up of 0-13 alpha or numeric characters.



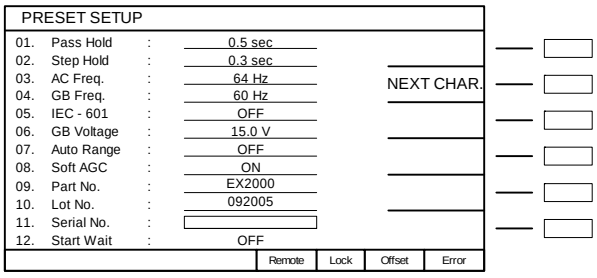
Use Function Key [NEXT CHAR] to move cursor to next character
Use Numeric Keys then [ENTER]
Enter the Message: 0 - 13 alpha-numeric characters

PRESS
[0] 1x → 0 [ENTER] [NEXT CHAR]
[9] 1x → 9 [ENTER] [NEXT CHAR]
[2] 1x → 2 [ENTER] [NEXT CHAR]
[0] 1x → 0 [ENTER] [NEXT CHAR]
[0] 1x → 0 [ENTER] [NEXT CHAR]
[5] 1x → 5 [ENTER] [NEXT CHAR]
[ENTER]
[EXIT]

Example Lot No.: 092005

2.6.11 Serial No.

The SERIAL NUMBER function allows the operator to assign a serial number to the device under test. To access Serial No., press [PRESET] and then the [↓] or [↑] arrow on the keypad so the backlit box is to the right of Serial No. Use the numerical keys to select first character then use [NEXT CHAR] to move the underscore cursor to the next character. When finished entering the serial number string, press [ENTER]. The serial number can be made up of 0-13 alpha or numeric characters.



Use Function Key [NEXT CHAR] to move cursor to next character
Use Numeric Keys then [ENTER]
Enter the Message: 0 - 13 alpha-numeric characters

PRESS

[1]	2x → A	[ENTER]	[NEXT CHAR]	
[5]	3x → N	[ENTER]	[NEXT CHAR]	
[4]	1x → 4	[ENTER]	[NEXT CHAR]	
[5]	1x → 5	[ENTER]	[NEXT CHAR]	
[6]	1x → 6	[ENTER]	[NEXT CHAR]	
[0]	1x → 0	[ENTER]	[NEXT CHAR]	
[0]	1x → 0	[ENTER]	[NEXT CHAR]	
[0]	1x → 0	[ENTER]	[NEXT CHAR]	
		[ENTER]		

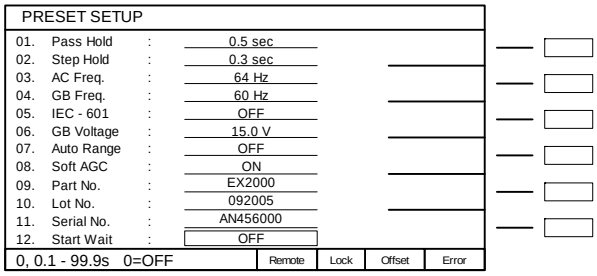
[EXIT]

Example Serial No.: AN456000

2.6.12 Start Wait

The Start Wait time is a delay time – after connection to the device is made and before current is applied to begin the ground bond test. This feature is normally used in a probing application. For example: If a 2 second start wait time is programmed, once the continuity between high and low GB connections is made, the G6100 Plus unit waits the 2sec programmed start time then applies current to the DUT.

To access Start Wait, press [PRESET] and then the [↓] or [↑] arrow on the keypad so the backlit box is to the right of Start Wait. Use the function keys [UP] or [DOWN] to increase or decrease the time the instrument will wait before a GB test. The Start Wait range is 0, 0.1 – 99. 9 seconds and the default setting is 0 (OFF).



CAUTION

The START WAIT function is ACTIVE until the [STOP] button is pressed. When START WAIT is ON, the G6100 Plus instrument will **start** if contact is made with the test leads.

2.7 TEST

To access TEST, press the [MENU] function key at the top left hand corner of the keypad and press the function key [TEST]. There are 2 functions within the TEST menu: Offset and Get Cs. Refer to Figure 2-21. If KEY LOCK is ON, the RECALL button is accessible from the Test Menu.

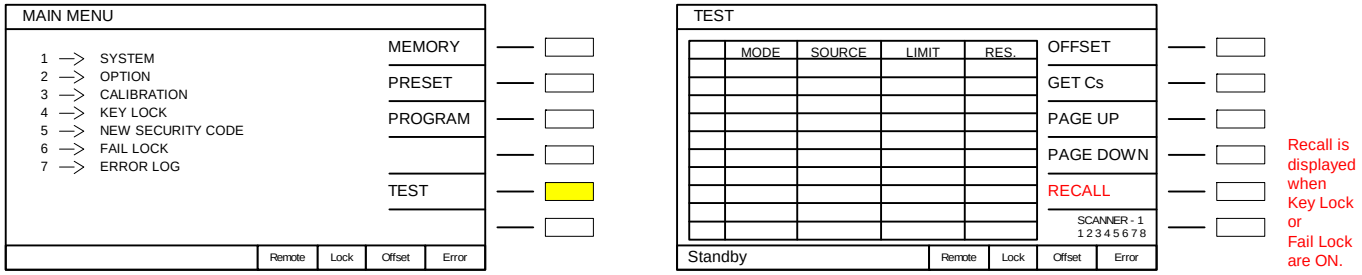


Figure 2-21: TEST SETUP

To access either of these 2 functions, press the function key that corresponds to the desired parameter.

Note:
When Key Lock and/or Fail Lock are ON, the G6100 Plus unit will power on to the Test Menu.

2.7.1 Offset

The Guardian 6100 Plus provides automatic offset for lead or fixture effects. During the offset process a correction is made (subtracted out) as the result of lead leakage current and stored in instrument memory to be applied to ongoing measurements. For maximum measurement accuracy it is recommended that offset be performed after power-up, any time the test parameters are changed and any time the test leads or fixture are changed. The offset is saved under setup storage (1-100 setups) and is also saved on a power down and power back up. Allow the instrument to warm-up for at least 15 minutes before performing offset.

Test parameters and Preset paramenters should be programmed and test cables connected prior to initializing the offset function. Refer to ¶2.7.3 for the correct cable connection.

Open connection using S02 Lead Set:

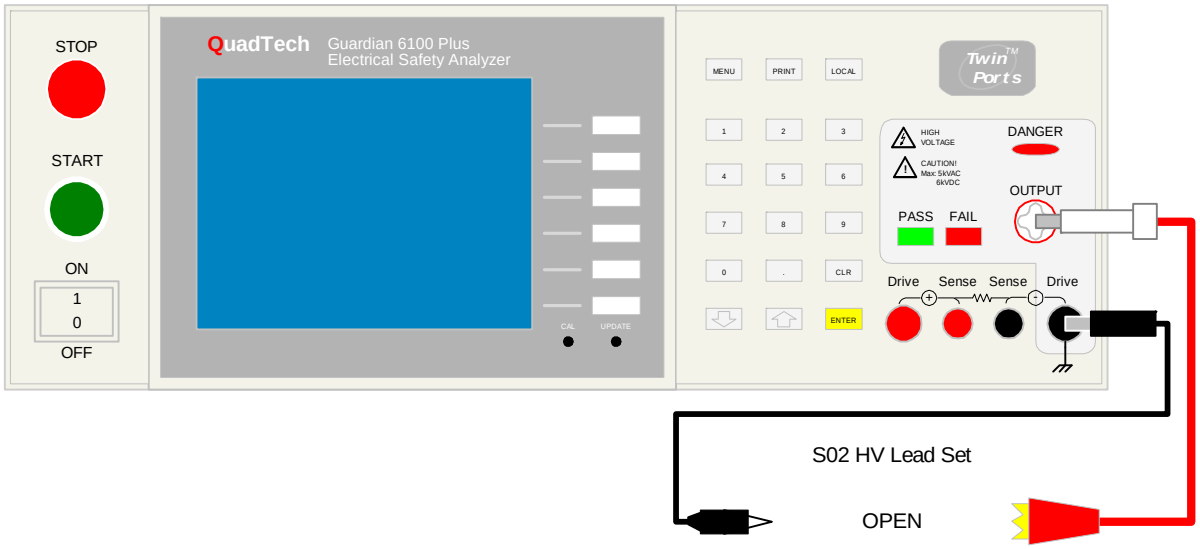


Figure 2-22: Offset OPEN Configuration

Short connection using G15 Lead Set:

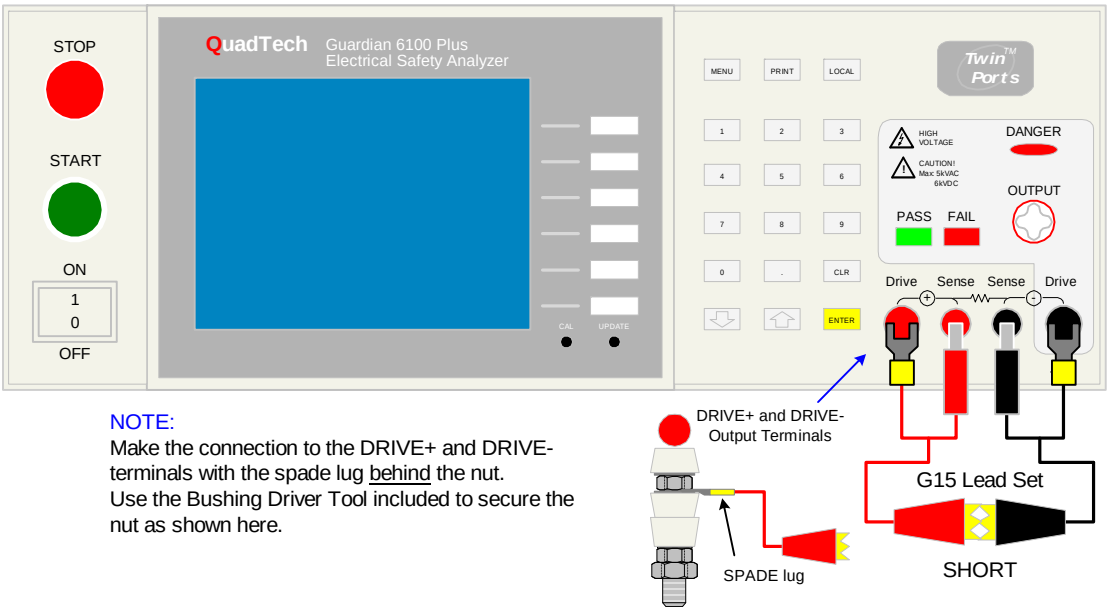


Figure 2-23: Offset SHORT Configuration

Offset Short Configuration

Figure 2-24 illustrates the short connection when the device under test is connected to the G30 Corded Product Adapter. The Drive+ terminal is shorted to the ground of the adapter.

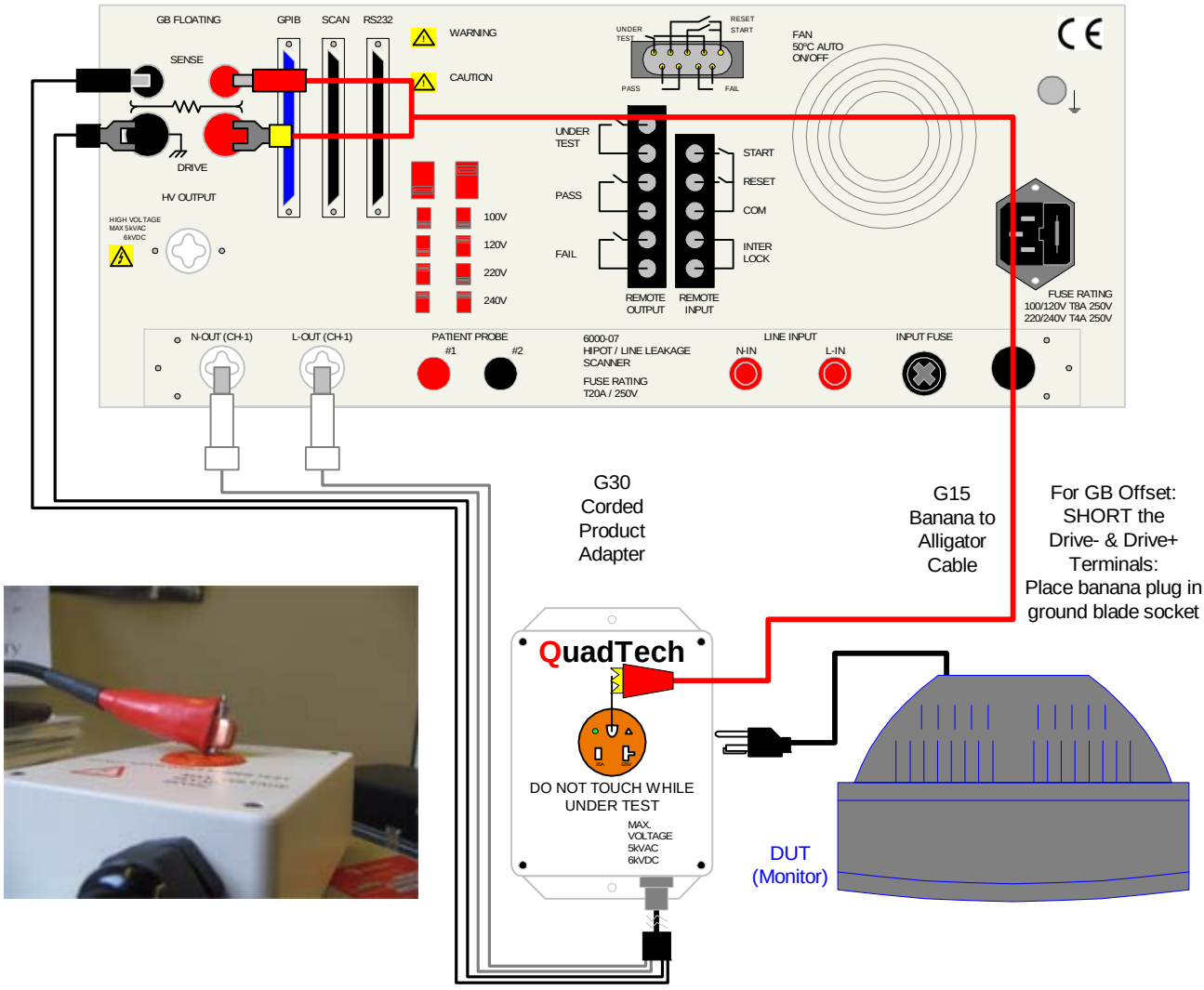
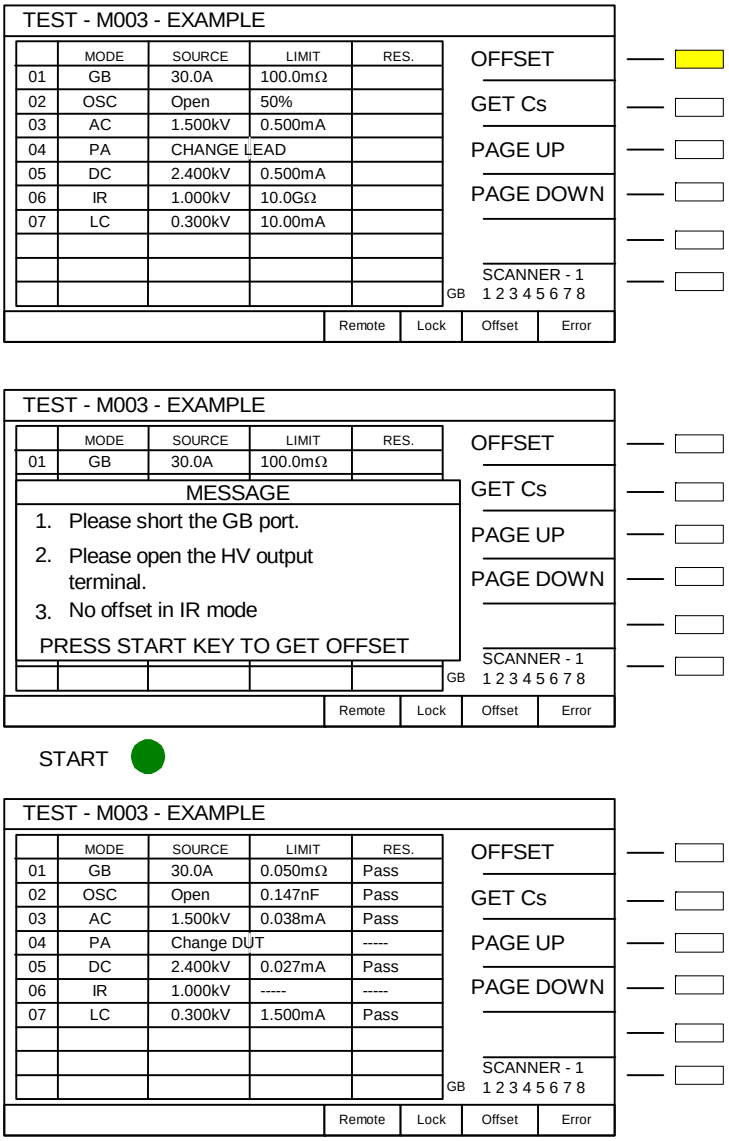


Figure 2-24: Offset Short using G15 and G30 Corded Product Adapter

Offset – continued

Plug the appropriate cable (or other fixture) into the OUTPUT connectors, **with no device connected**. Refer to ¶ 2.7.3 for cable connections. Note: Test leads for AC Hipot DC Hipot and OSC measurements should be OPEN and test leads for GB should be SHORTED before the OFFSET function is activated.

In MAIN MENU, Press [TEST] function key to enter Test Menu.
Press the [OFFSET] function key
Press the green [START] button.



Green Offset LED will illuminate.
Press the [ENTER] key to acccept Offset values.

Offset – continued

The following formulas apply to the offset function:

For DC offset:

Display current = (current read) - (offset current)

For AC offset:

If Measured Value < Value set in ¶ 2.3.1.9:

$$\text{Display current} = \sqrt{(\text{current read})^2 - (\text{offset current})^2}$$

If Measured Value > Value set in ¶ 2.3.1.9:

Display current = (current read) - (offset current)

For LC offset:

If Measured Value < Value set in ¶ 2.3.1.10:

$$\text{Display current} = \sqrt{(\text{current read})^2 - (\text{offset current})^2}$$

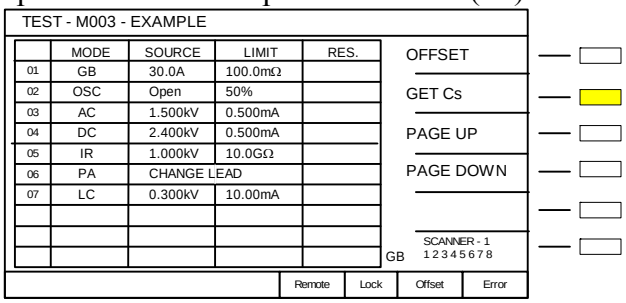
If Measured Value > Value set in ¶ 2.3.1.10:

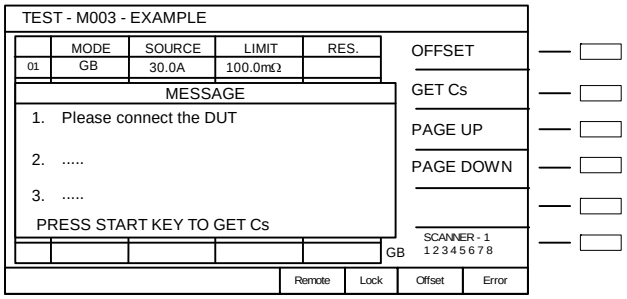
Display current = (current read) - (offset current)

NOTE
When in LC Mode, the following must hold true: Offset Leakage + High Limit < Measurement Range
For example, when the High Limt is 0.50mA and the instrument is in the 5999 mA range, if Offset current > 0.1mA, any attempt to perform an Offset will result in HIGH FAILURE.

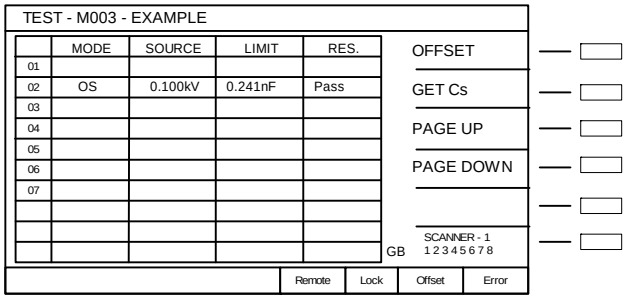
2.7.2 GET Cs (OSC)

Refer to ¶ 2.4.2 for a full description of the Open/Short Circuit detection mode. In MAIN MENU, press [TEST] to enter Test Menu. **Run OFFSET first** (open circuit) and then connect the 'known good' DUT. Press the [GET Cs] function key to obtain the open/short circuit capacitance value (Cs).





START



Press [ENTER] to accept Cs value. The Cs value will be stored in memory with the test setup.

2.7.3 Connecting the Device Under Test (DUT)

Before connecting the DUT, press the red **[STOP]** key and make sure the red **DANGER** light is **OFF**.

Depending on the test to be conducted (Hipot, IR, LC or Ground Bond) connect the test cables to the OUTPUT connectors. Refer to the Figures 2-25 through 2-32 to determine the correct configuration. When using the black cable, with the metal retaining bracket, make sure it is locked behind the connector to prevent this cable from accidentally coming loose.

WARNING
NEVER TOUCH THE TEST LEADS OR THE DEVICE UNDER TEST WHEN THEY ARE CONNECTED TO THE INSTRUMENT AND THE RED DANGER LIGHT IS ON OR FLASHING.

2.7.3.1 S02 Lead Set

The S-02 Cable Lead Set connects the product to G6100 Plus unit through a two lead set. The leads consist of a white plug for connection to HV OUTPUT and a black banana plug with retaining bracket for connection to the Drive- terminal. Figure 2-25 illustrates the connection of the S-02 Cable Lead Set to the G6100 Plus instrument.

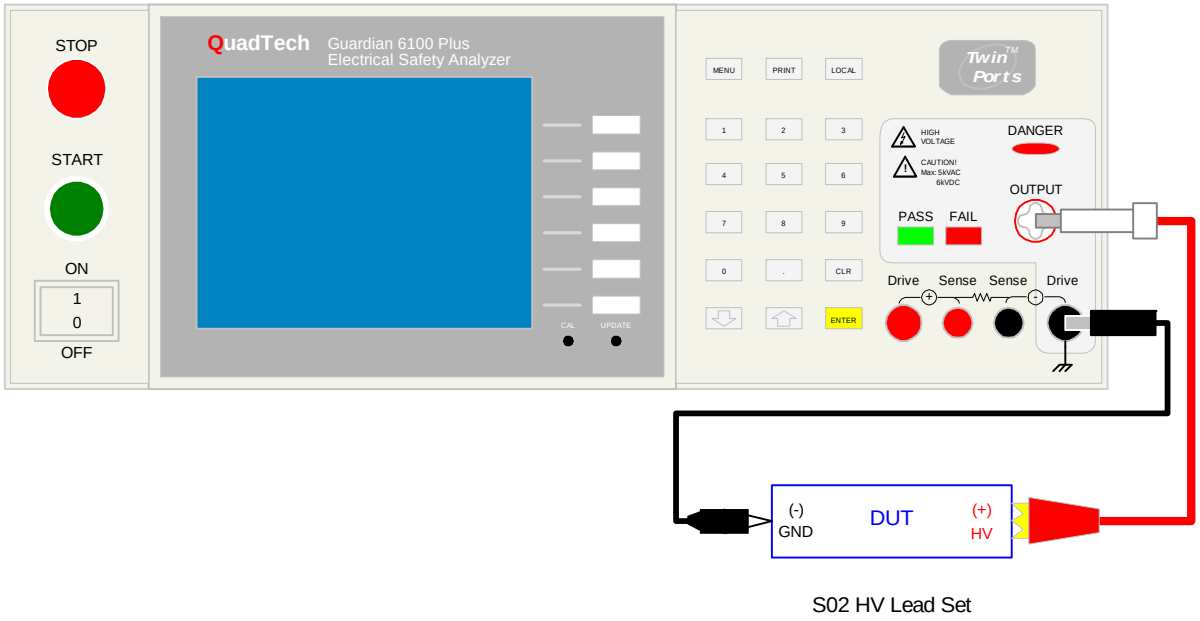


Figure 2-25: Connection for Hipot/IR Test (Using S02 Cable Lead Set)

2.7.3.2 G30 Corded Product Adapter

The G-30 Corded Product Adapter consists of a hospital grade receptacle and four leads for a three-wire connection of the product to the G6100 Plus instrument. Connection is via the rear panel output and scanner connectors. The G30 leads consist of two white custom banana plugs for connection to L-OUT and N-OUT, a black banana plug for connection to the Sense- terminal, and a black spade lug for connection to the Drive- terminal. Figure 2-26 illustrates the connection of the G-30 Corded Product Adapter to the G6100 Plus unit.

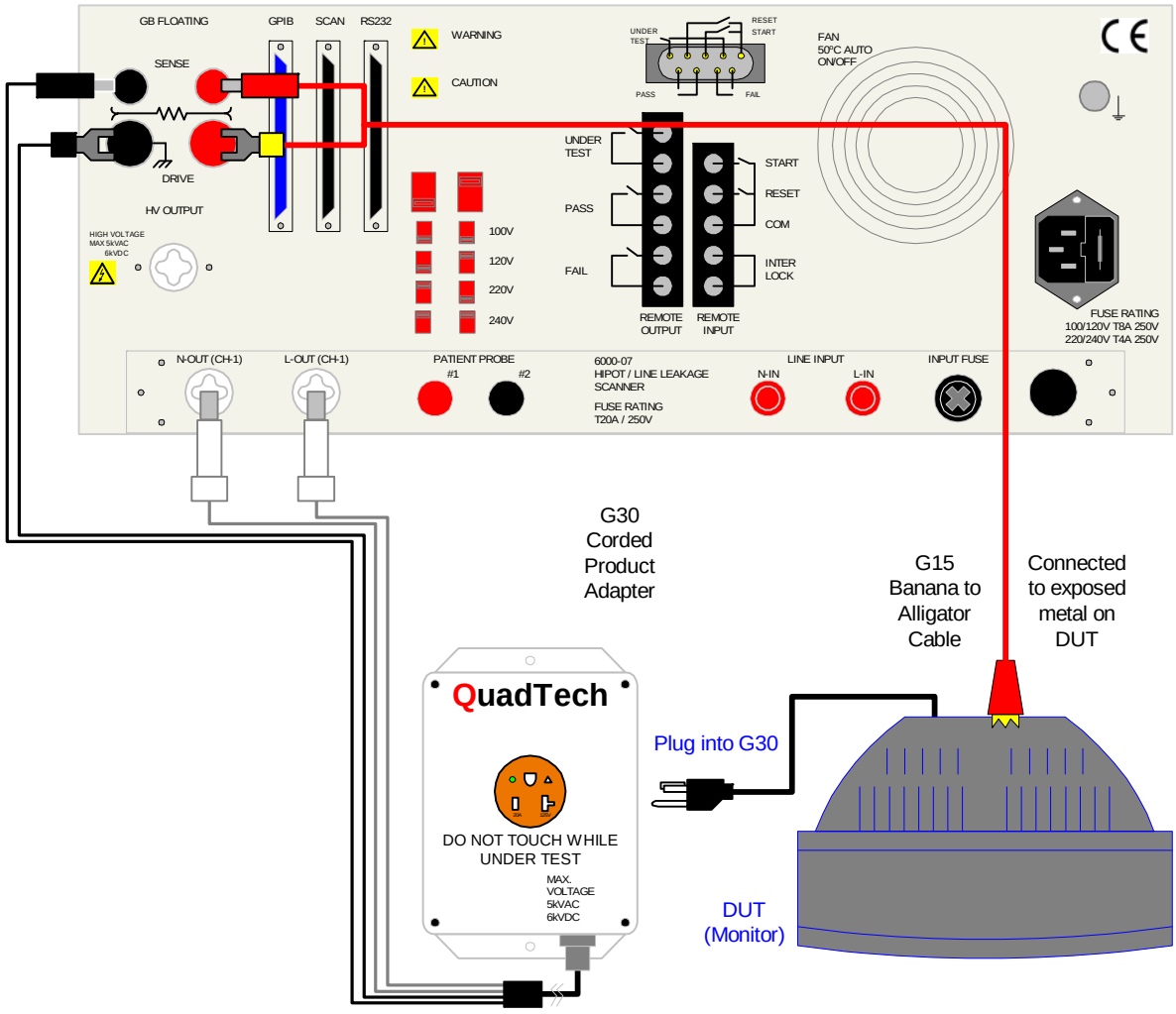


Figure 2-26: G30 Connection to G6100 Plus for GB & Hipot

G14 Power Entry Adapter

The G-14 Power Entry Adapter Cable allows an AC inlet connection of product to G6100 Plus instrument through a three lead set. The leads consist of a white plug for connection to HV OUTPUT, a black banana plug with retaining bracket for connection to the Sense- terminal, and a black spade lug for connection to the Drive- terminal. Figure 2-27 illustrates the connection of the G-14 Power Entry Adapter Cable to the G6100 Plus unit.

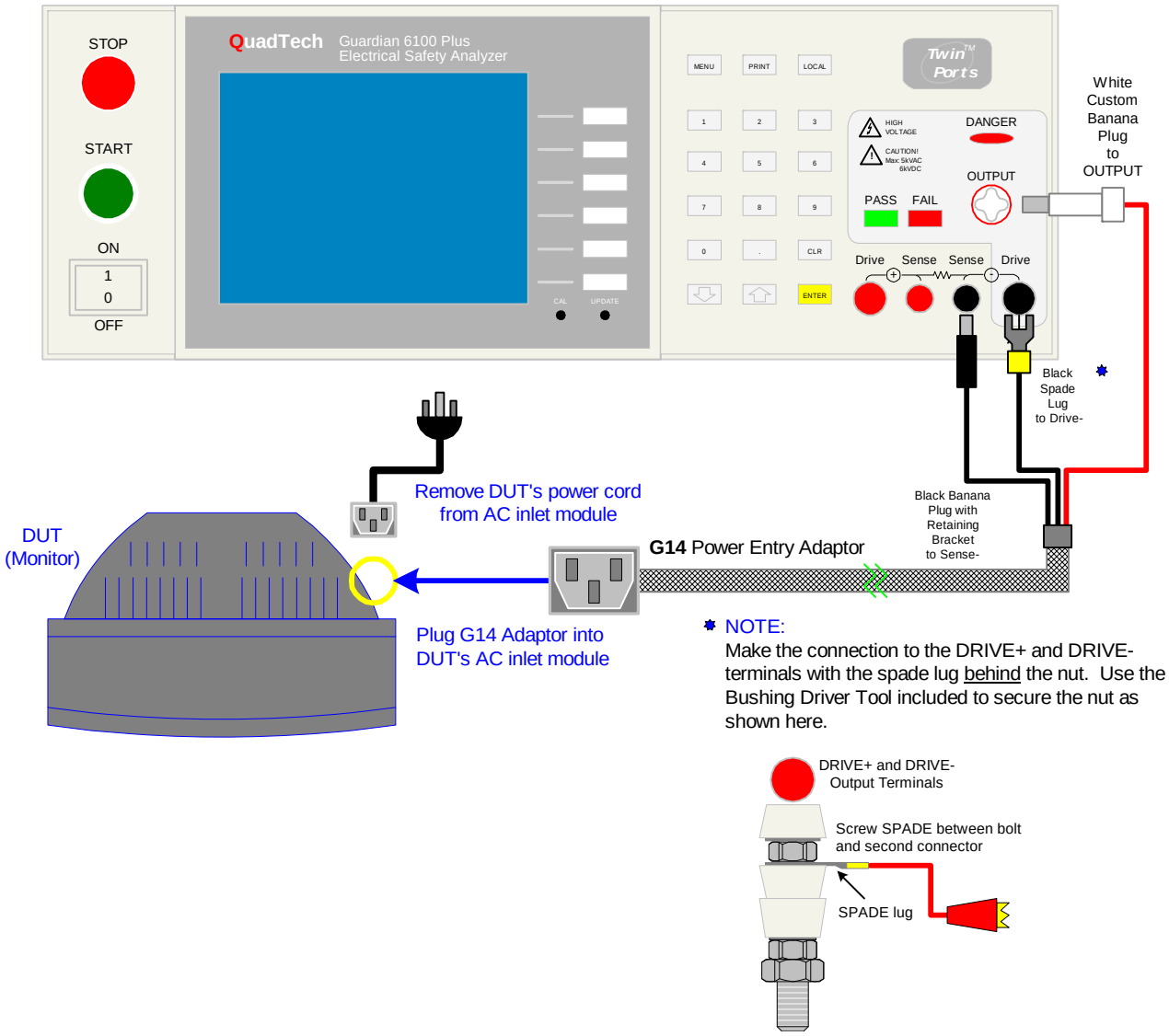


Figure 2-27: Connection for Hipot Test (Using G14 Power Entry Cable)

2.7.3.3 G15 Ground Continuty Lead Set

The G-15 Ground Continuity Lead Set provides 4-terminal connection of product to the G6100 Plus instrument through a pair of banana/spade to alligator clip leads. The black banana plug and spade lug connect to the (-) side of the output terminals and product. The red banana plug and spade lug connect to the (+) side of the out put terminals and product. Make the connection to the Drive + and Drive – terminals with the spade lug positioned behind the nut.

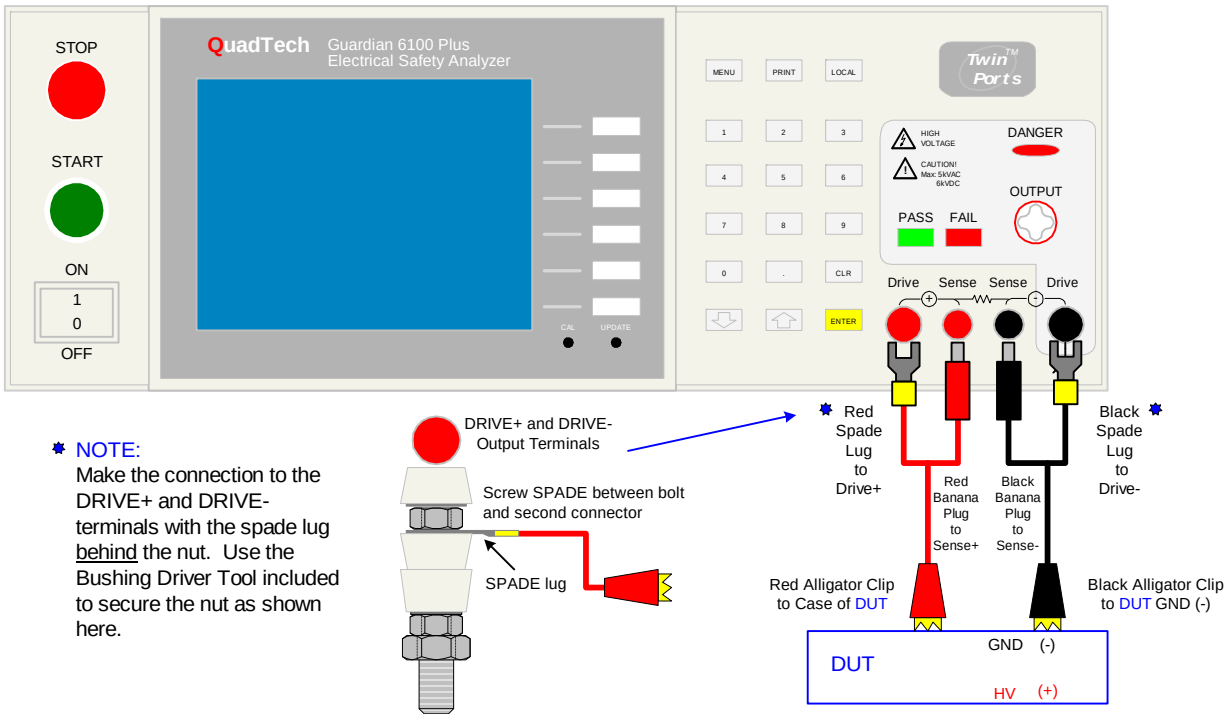


Figure 2-28: Connection for Ground Continuity Test (Using G15 Cable Lead Set)

2.7.3.4 G15 and S02 Lead Sets

Use both leads of the G-15 Ground Continuity Lead Set. The black banana plug and spade lug connect to the (-) side of the output terminals and product. The red banana plug and spade lug connect to the (+) side of the out put terminals and product. Make the connection to the Drive + and Drive – terminals with the spade lug positioned behind the nut. The S-02 Cable Lead Set connects the product to G6100 Plus unit through a two lead set. Connect the white plug to HV OUTPUT. The black banana plug with retaining bracket for connection to the Drive- terminal is not needed when using the G15 with the S02.

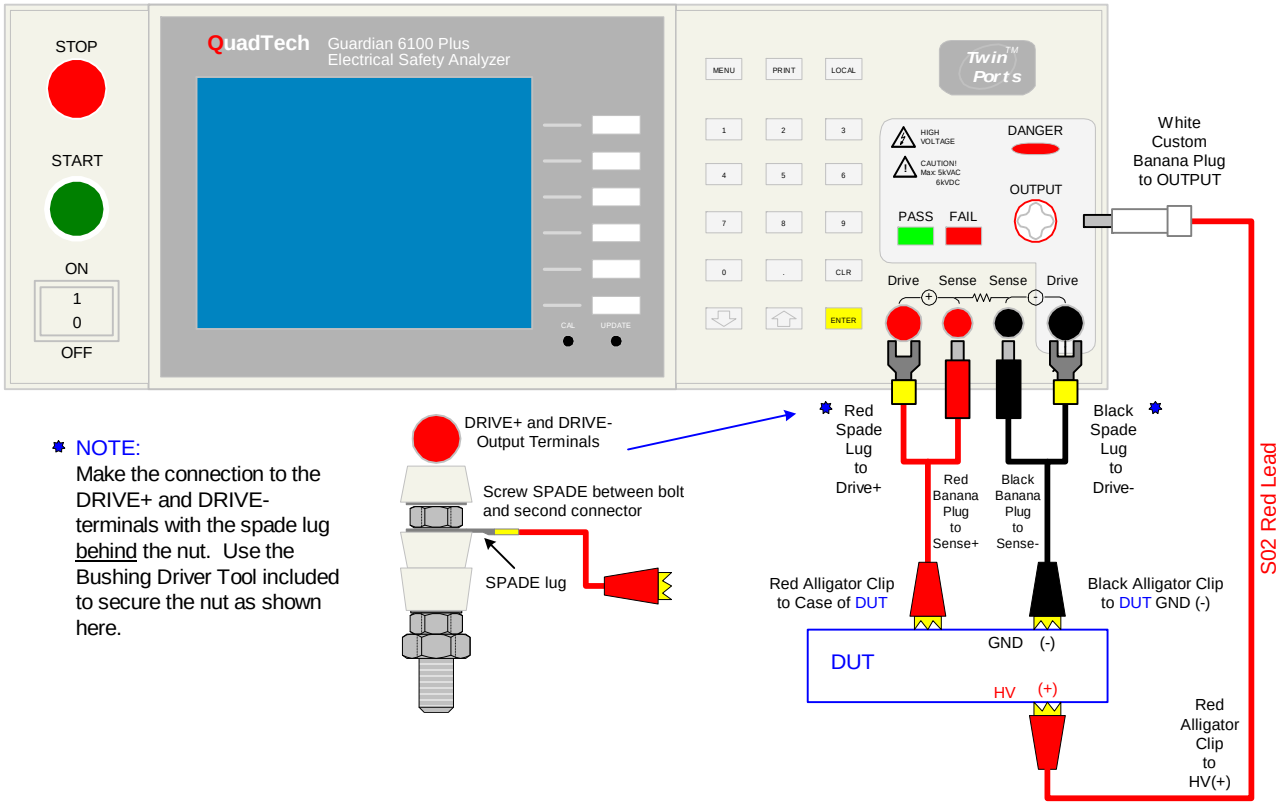


Figure 2-29: Connection for Hipot and GB Test (Using S02 & G15 Lead Sets)

2.7.3.5 G15 and G14 Lead Sets

With the G-15 Ground Continuity Lead Set, connect the red banana plug and spade lug connect to the (+) side of the out put terminals and product. Make the connection to the Drive + terminal with the spade lug positioned behind the nut. The G-14 Power Entry Adapter Cable allows an AC inlet connection of product to G6100 Plus instrument through a three lead set. Connect the white plug to HV OUTPUT, the black banana plug with retaining bracket to the Sense- terminal, and the black spade lug to the Drive- terminal.

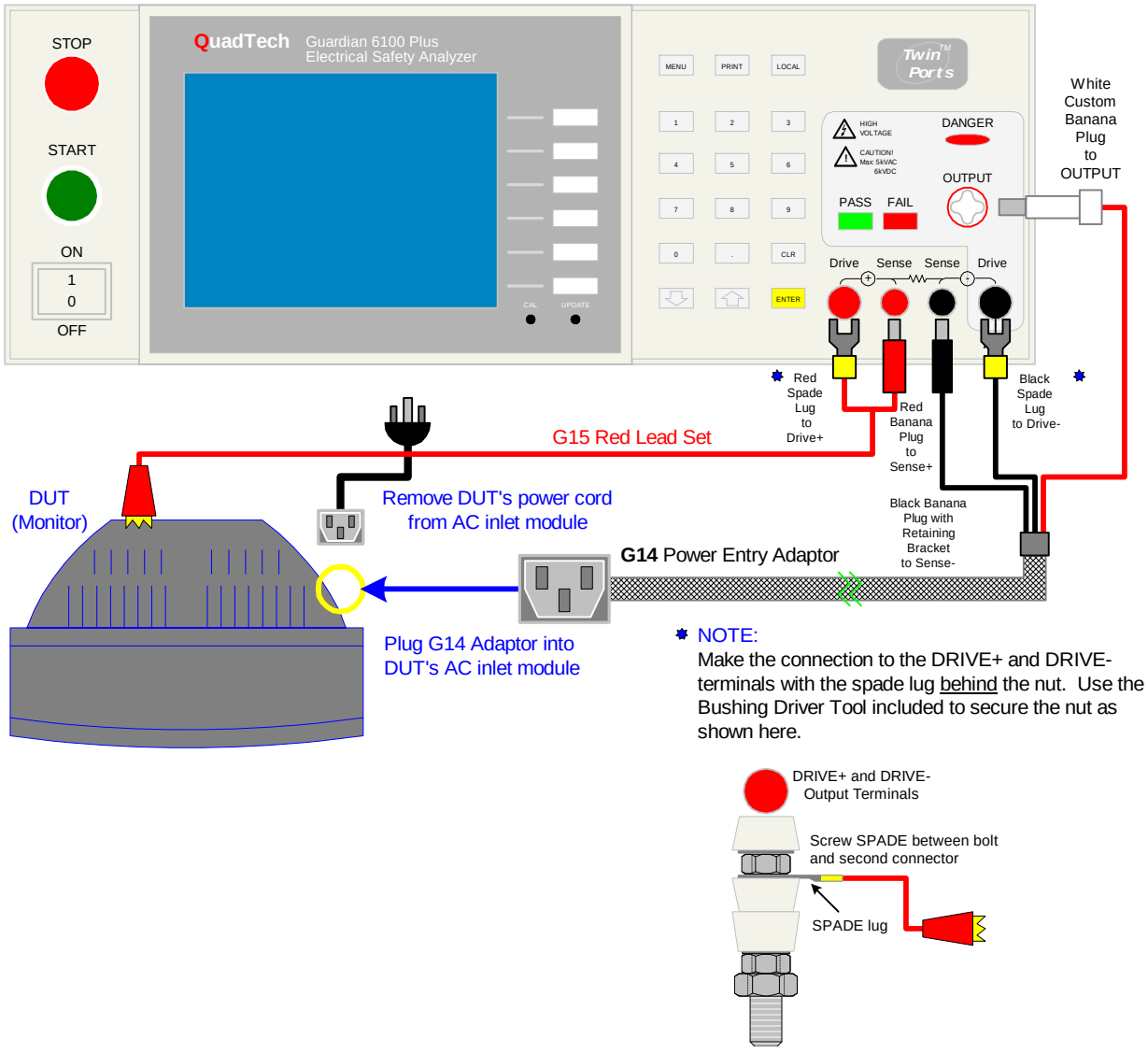


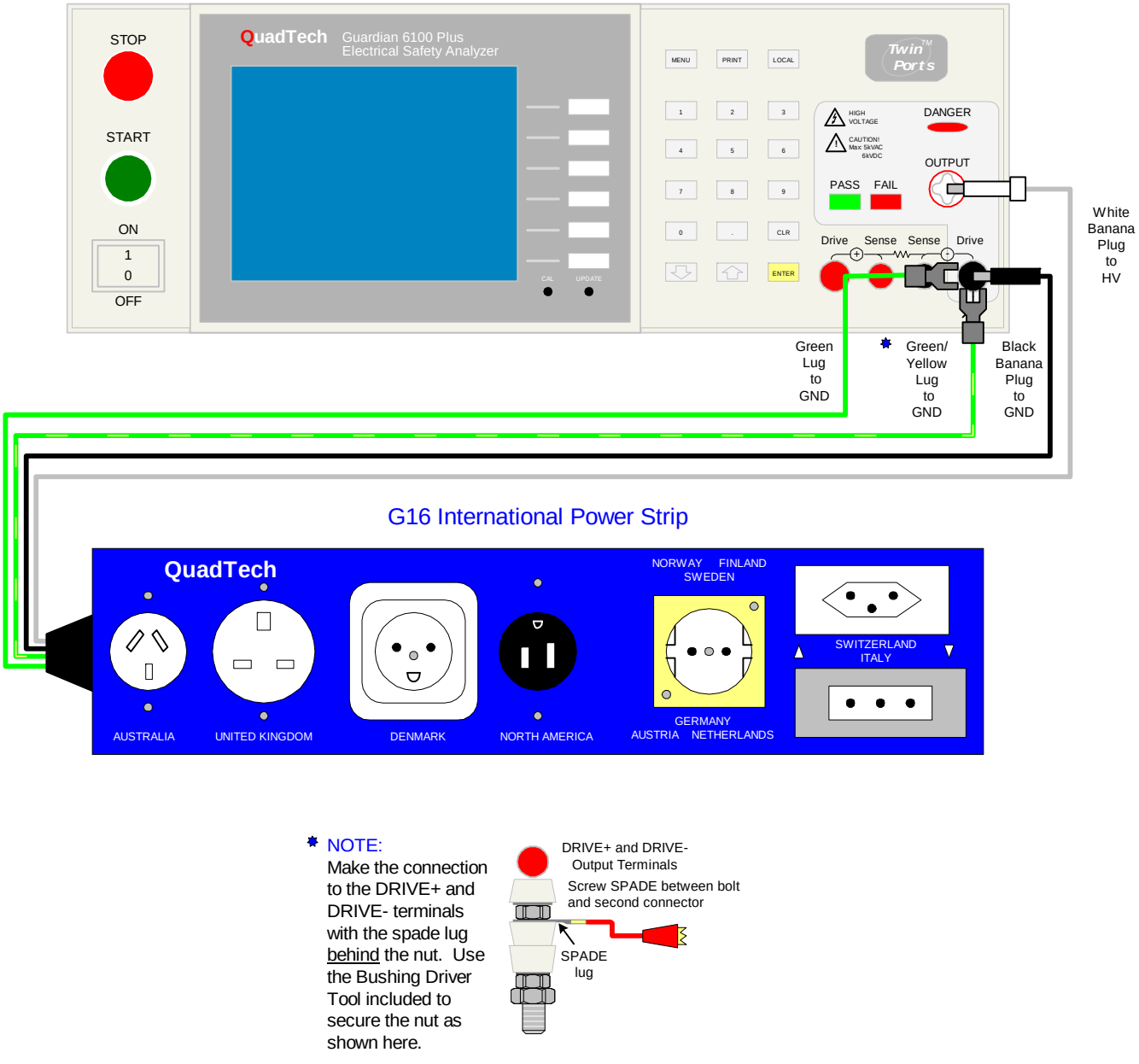
Figure 2-30: Connection using G15 (red only) **& G14 Cables**

2.7.3.6 G16 International Power Strip

The G16 International Power Strip allows connection of standard corded products from several different countries. These countries are:

* Australia	* United Kingdom	* Denmark
* North America	* Norway	* Finland
* Sweden	* Germany	* Netherlands
* Austria	* Switzerland	* Italy

Refer to Figure 2-31 for connection of the G16 International Power Strip to the Guardian 6100 Plus instrument output terminals.



* NOTE:
Make the connection to the DRIVE+ and DRIVE- terminals with the spade lug behind the nut. Use the Bushing Driver Tool included to secure the nut as shown here.

Figure 2-31: G16 connection to G6100 Plus

2.7.3.8 G45 40A Ground Bond Transformer

The G45 40A Ground Bond Transformer comes with two lead sets, one to connect G6100 Drive/Sense terminals to the G45 INPUT terminals and the second to connect the G45 OUTPUT terminals to the DUT. Make the connection to the INPUT Drive +/Drive- terminals with the spade lug positioned behind the nut.

Connect the Spade-to-Spade lead set between the G6100 Drive/Sense terminals and the G45 INPUT terminals. The red wire between Drive +/Drive+. The black wire between Drive-/Drive-. The blue spades to Sense+ and Sense- terminals. Connect the Banana/Spade-to-Alligator lead set between the G45 OUTPUT terminals and the DUT.

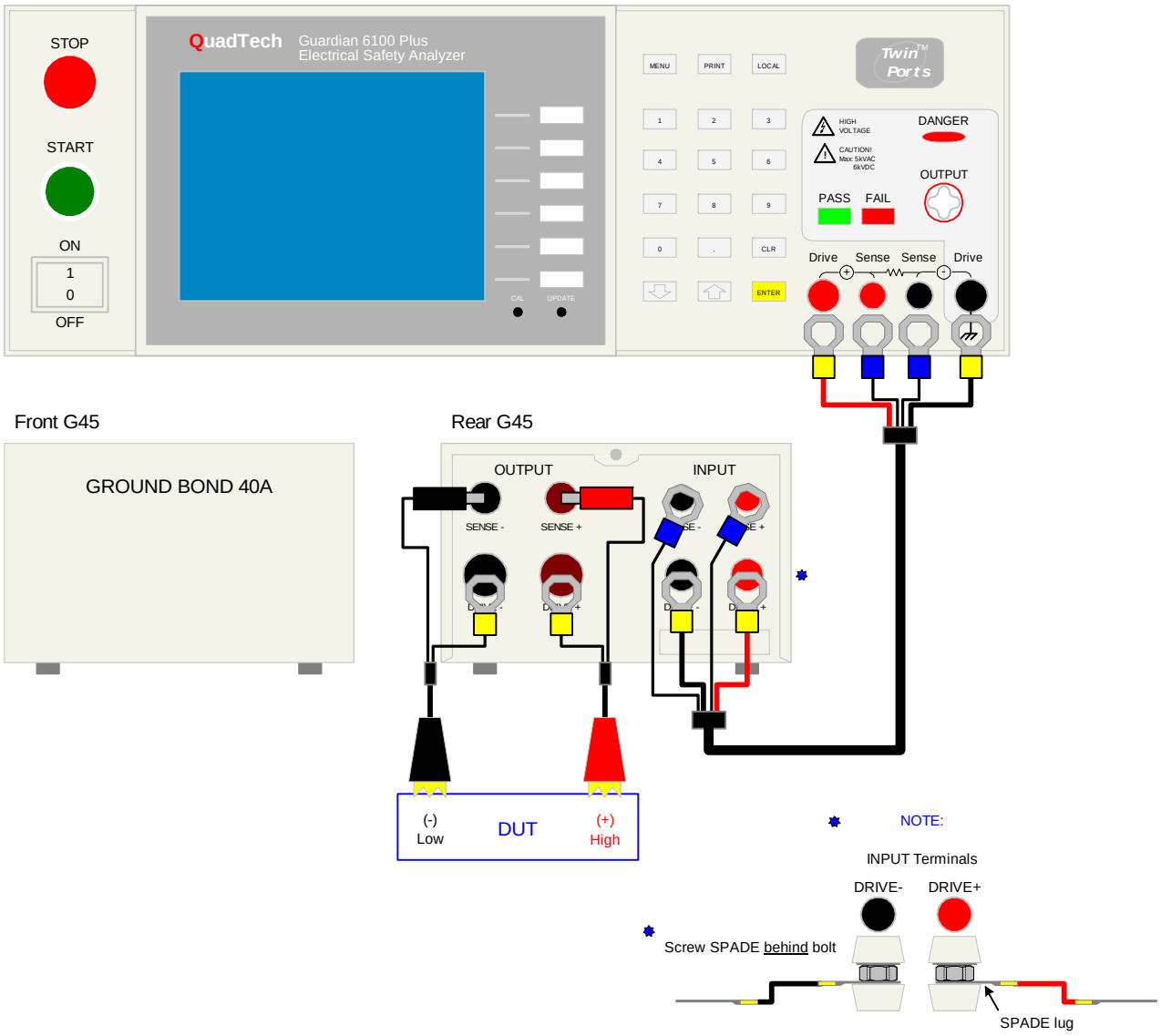


Figure 2-32: G45 connection to G6100 Plus

2.7.4 Measurement Procedure

Before a measurement is made, verify the following:

- Guardian 6100 Plus unit power is ON
- 15 minute warm-up
- Test parameters programmed
- Offset function completed
- OSC – Get Cs completed
- Device Under Test (DUT) connected

Perform a test at power-up conditions (test conditions at which the instrument was last powered down), or recall one of 100 possible stored setups. Refer to paragraphs 2.4 and 2.5 for instructions to change the test mode and/or test conditions.

To initiate a test at "power-up conditions" proceed as follows:

1 Press [TEST] to enter Test Menu
2 Press [STOP] Offset LED is backlit
3 Press [START] Danger LED flashes, Offset LED is backlit
4 Press [STOP] At any time to stop test

2.7.5 Viewing Test Results

Test results are displayed upon completion of a test in the right hand column labeled 'RES.". Use [PAGE UP] or [PAGE DOWN] to view additional steps over 10.

2.8 PRINT

The [PRINT] button on the front panel of the G6100 Plus instrument is used when the Printer interface is installed. Press [PRINT] to print out the Test results as shown on the display.

2.9 LOCAL

The [LOCAL] button on the front panel of the G6100 Plus instrument acts as a toggle switch and is used when the G6100 Plus is being controlled via the RS-232 or IEEE-488 interface. The G6100 Plus is in remote status when the REMOTE LED is ON. To switch to Local from Remote press the [LOCAL] function key. The [LOCAL] and [STOP] buttons are the only functional keys when the unit is in REMOTE mode.

Section 3 : Interface

Note:
Remote operation and automation of the Guardian 6100 Plus instrument can be accomplished using QuadTech's CaptivATE© Automation Software.

3.1 Remote

A 9 pin D-series remote control connector is located on the rear panel of the G6100 Plus instrument. There is a black 6 screw relay strip for the remote output signals : UNDER TEST, PASS & FAIL. There is a black 5 screw relay strip for the remote input connections : START, RESET, COM & INTER LOCK. Inputs require a contact closure and outputs provide a contact closure, as shown in Figure 3-1.

Before connecting the instrument to its power source the **interlock function** on the rear panel remote connector must be properly utilized. **This is an important safety feature for the protection of the operator.** Turn on of the instrument's high voltage is prohibited with no interlock connection and is functional with the interlock jumper in place (as shipped from the factory).

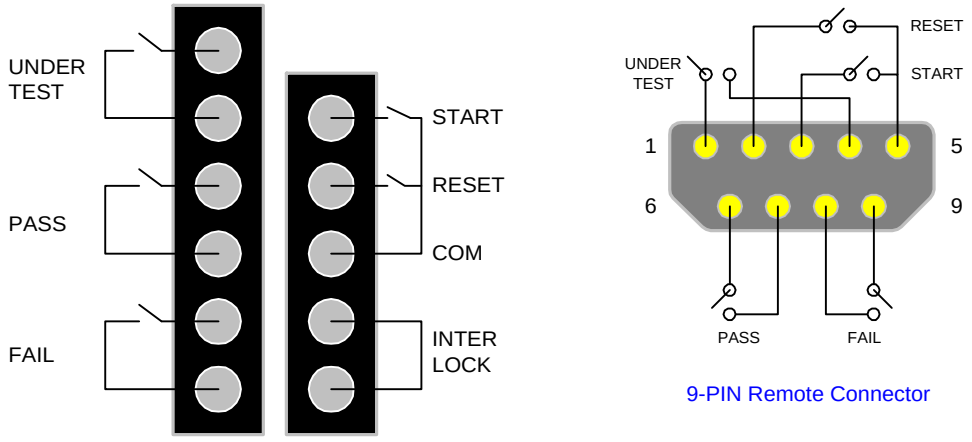


Figure 3-1: Remote Control Connections

The G6100 Plus unit has three output signals on the rear panel. The UNDER TEST output terminal is short during TEST as the relay contacts connect to the device powered by 115VAC and current < 0.3A. The PASS output terminal is short when DUT is judged GOOD. The FAIL output terminal is short when DUT is judged NO-GOOD.

Figures 3-2 and 3-3 illustrate possible remote control connections. Use extreme care when using a remote control connection as the High Voltage Output is being turned ON and OFF with with an external signal.

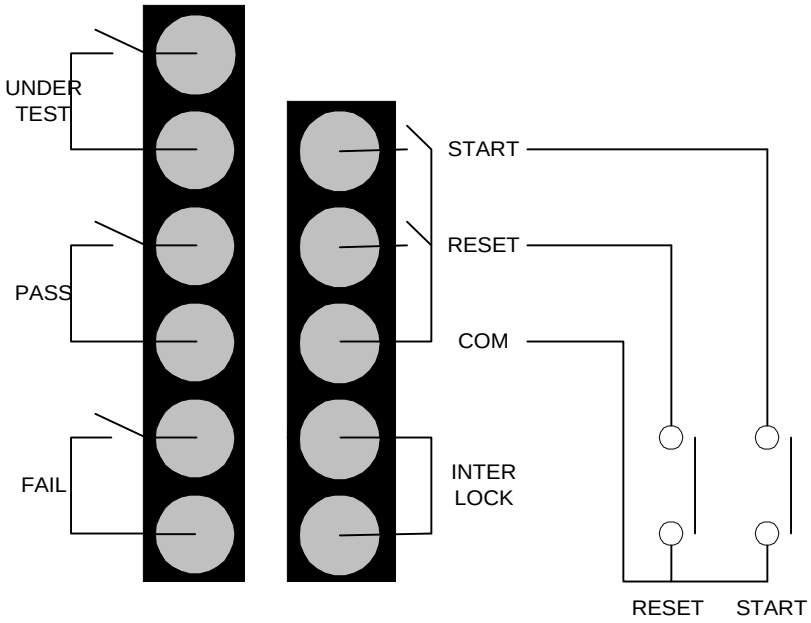


Figure 3-2: Single Control of TEST or STOP

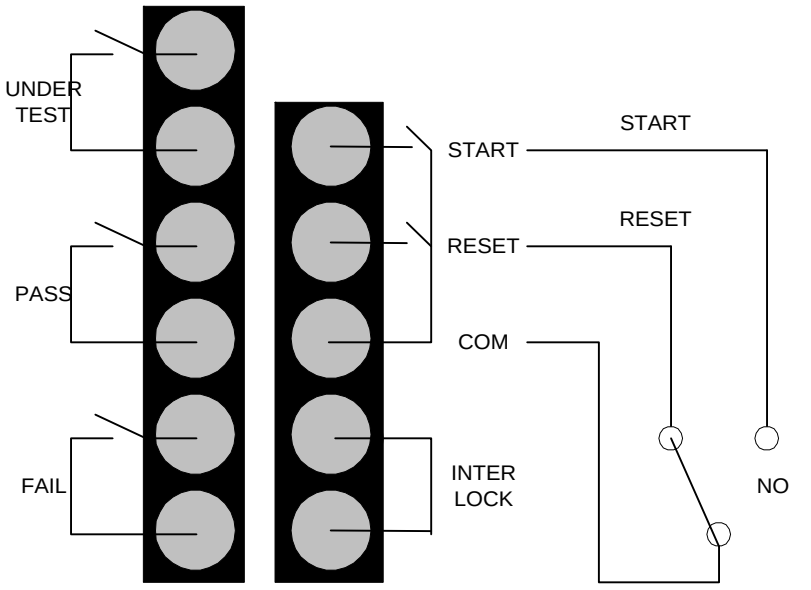


Figure 3-3: Continuous Control of STOP

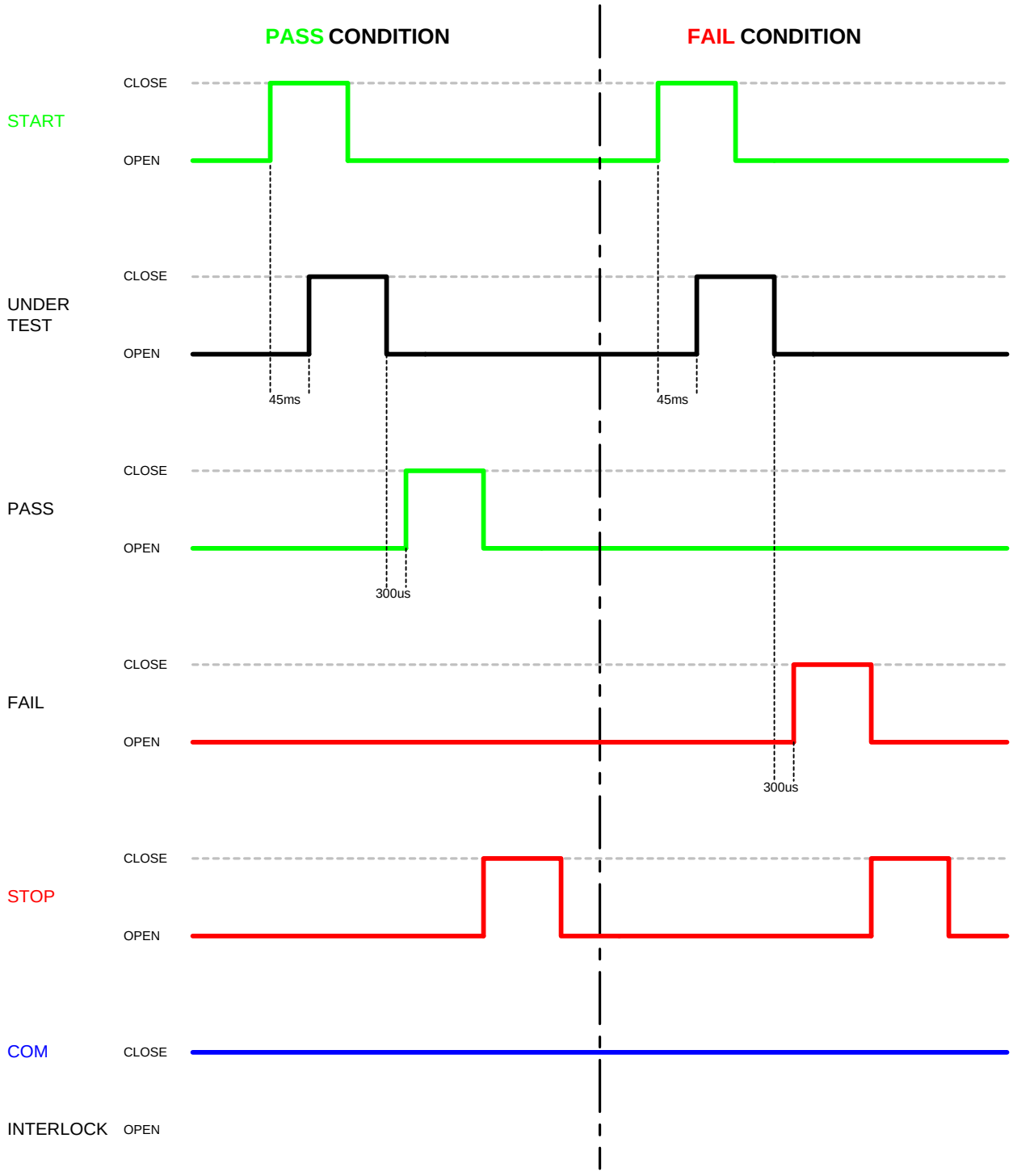


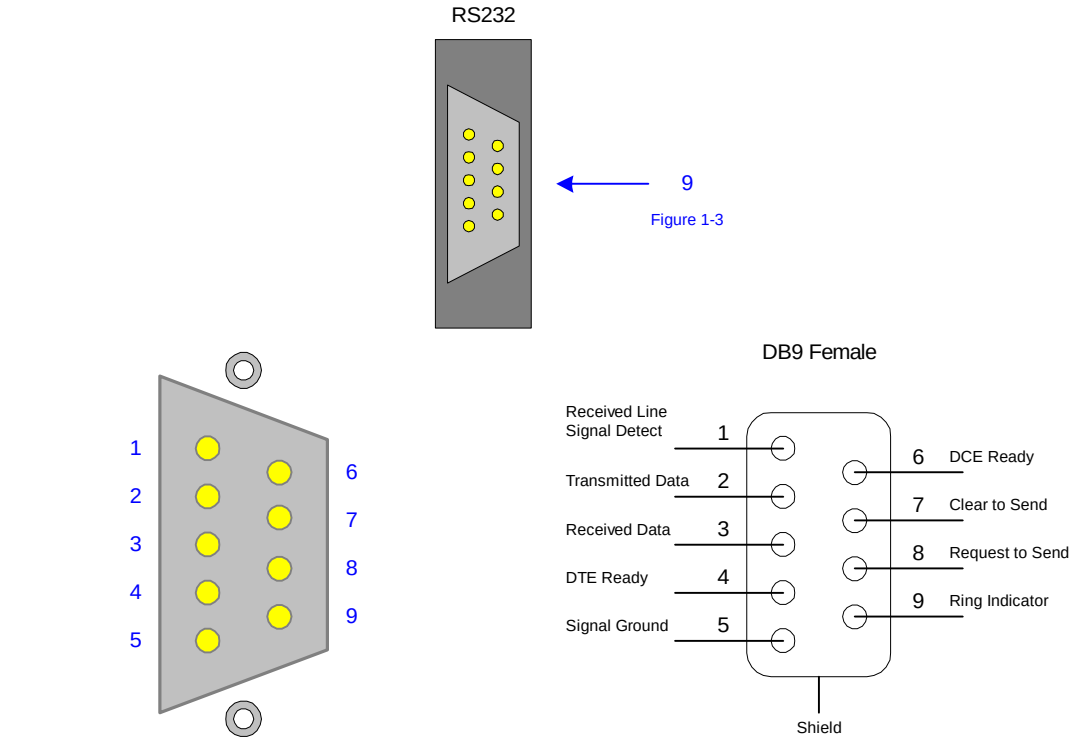
Figure 3-4: G6100 Plus Timing Diagram

3.2 RS232 Interface

3.2.1 PIN Configuration

An RS232 interface is standard equipment on the Guardian 6100 Plus instrument. Connection is through the black 9-PIN connector labeled 'RS232' on the rear panel of the Guardian 6100 Plus unit. Figure 3-5 illustrates the RS232 PIN configuration.

> Note:
> When the RS232 Interface and the IEEE-488 Interface are both installed in a Guardian 6100 Plus unit, only one of the two interfaces may be activated at a time.



Guardian 6100 Plus
RS232 Interface PIN Configuration: Rear Panel View

Guardian 6100 Plus
RS232 Interface Pin Designations

Figure 3-5: RS232 PIN Configuration

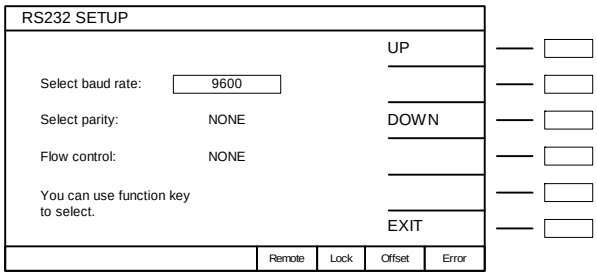
3.2.2 RS232 Specifications

Data bits:	8 (or 7 data bits and 1 parity bit)
Stop bits:	1
Start dits:	1
Parity:	None/Odd/Even
Baud Rate:	300/600/1200/2400/4800/9600/19200 bps
Flow Control:	None/Software
EOS:	CR + LF

Selecting Baud Rate

Setting the baud rate is done in the [OPTION] submenu, ¶ 2.3.2.1.

Use RS-232 to set the baud rate, parity and flow control for the RS-232 interface. To access RS-232 Setup, press [MENU], [2] and the function key [RS-232]. The backlit box is next to 'Select baud rate'. Use the [UP] or [DOWN] function key to select the baud rate = 300, 600, 1200, 2400, 4800, 9600 or 19200. The default value is 9600 bps.



Use the [↓] arrow on the keypad so the backlit box is to the right of 'Select parity'. Use the [UP] or [DOWN] function key to select the parity = ODD, EVEN or NONE. The default value is NONE.

Use the [↓] arrow on the keypad so the backlit box is to the right of 'Flow control'. Use the [UP] or [DOWN] function key to select the parity = NONE or SOFTWARE. The default value is NONE.

Use the [EXIT] key to exit RS232 Setup and return to Option Menu.

3.2.3 RS232 Commands

The command set for the RS232 interface is the same as the IEEE-488 interface command set listed in paragraphs 3.3.2 through 3.3.4 of this Instruction Manual.

Note:
CR + LF is the end code for the RS232 Commands.

3.2.4 Sample QuickBasic Program

```
REM  Guardian 6100 Plus RS232 example program
REM  Created using Quick Basic

REM open serial port as device 1
OPEN "COM1:9600,N,8,1,RS," FOR RANDOM AS #1
CLS
PRINT "This program will show the configurable commands for the G6100 Plus"
PRINT "Once the steps are programmed, the G6100 Plus will run the test"
PRINT " "
PRINT "*********************************************************"
PRINT "**************Caution High Voltage will be present********"
PRINT "*********************************************************"
PRINT " "
PRINT " The results from the test will be displayed on your monitor"


REM Send STOP command to device
PRINT #1, "SOURce:SAFEty:STOP"; CHR$(13); CHR$(10)

REM Ask device how many steps are programed
PRINT #1, "SOURce:SAFEty:SNUMBer?"; CHR$(13); CHR$(10)

INPUT #1, SNUMBer
REM Loop to delete any programed steps
IF SNUMBer > 0 THEN
    FOR I = SNUMBer TO 0 STEP -1
    IF I = 0 GOTO Program
    temp$ = INPUT$(LOC(1), 1)
    PRINT #1, "SOURce:SAFEty:STEP", I, ":DELete"; CHR$(13); CHR$(10)
    NEXT I
 END IF

Program:
PRINT "Programing G6000 Plus"

REM Program STEP 1 for osc - Open Short Circuit Test

REM Program OPEN for 50%
PRINT #1, "SOURce:SAFEty:STEP1:OSC:LIMIT:OPEN 0.5"; CHR$(13); CHR$(10)

REM Program OSC SHORT for 200%
PRINT #1, "SOURce:SAFEty:STEP1:OSC:LIMIT:SHORT 2"; CHR$(13); CHR$(10)

REM Program STEP 2 for Ground Bond Test

REM Program GB current for 10 A
PRINT #1, "SOURce:SAFEty:STEP2:GB:LEVel 10"; CHR$(13); CHR$(10)

REM Program low resitance limit for .1 mohm
PRINT #1, "SOURce:SAFEty:STEP2:GB:LIMIT:LOW 0.0001"; CHR$(13); CHR$(10)
```

```
REM Program test time for 5 sec
PRINT #1, "SOURce:SAFEty:STEP2:GB:TIME 2"; CHR$(13); CHR$(10)

REM Program high resistance limit 100mOHM
PRINT #1, "SOURce:SAFEty:STEP2:GB:LIMit:HIGH 0.1000"; CHR$(13); CHR$(10)

REM Program TWIN PORT off
PRINT #1, "SOURce:SAFEty:STEP2:GB:TPORT 0"; CHR$(13); CHR$(10)

REM Program STEP3 for AC HIPOT
REM Program AC test voltage for 1000 V
PRINT #1, "SOURce:SAFEty:STEP3:AC:LEVel 1000"; CHR$(13); CHR$(10)

REM Program high current limit for 6 mA
PRINT #1, "SOURce:SAFEty:STEP3:AC:LIMit:HIGH 0.006"; CHR$(13); CHR$(10)

REM Program test time for 3 seconds
PRINT #1, "SOURce:SAFEty:STEP3:AC:TIME:TEST 3.0"; CHR$(13); CHR$(10)

REM Program Low current limit off
PRINT #1, "SOURce:SAFEty:STEP3:AC:LIMit:LOW 0.000"; CHR$(13); CHR$(10)

REM Program ARC limit for 2 mA
PRINT #1, "SOURce:SAFEty:STEP3:AC:LIMit:ARC:LEVel 0.002"; CHR$(13); CHR$(10)

REM Program ARC Filter limit for 3-100kHz
PRINT #1, "SOURce:SAFEty:STEP3:AC:LIMit:ARC:FILTer 100e3"; CHR$(13); CHR$(10)

REM Program ramp time for 4 seconds
PRINT #1, "SOURce:SAFEty:STEP3:AC:TIME:RAMP 4.0"; CHR$(13); CHR$(10)

REM Program channel 1 high and channel 3 low
PRINT #1, "SOURce:SAFEty:STEP3:AC:CHAN:HIGH (@1(1))"; CHR$(13); CHR$(10)

PRINT #1, "SOURce:SAFEty:STEP3:AC:CHAN:LOW (@1(3))"; CHR$(13); CHR$(10)

REM Program STEP 4 for DC HIPOT
REM Program DC test voltage for 1000 V
PRINT #1, "SOURce:SAFEty:STEP4:DC:LEVel 1000"; CHR$(13); CHR$(10)

REM Program high current limit for 7 mA
PRINT #1, "SOURce:SAFEty:STEP4:DC:LIMIT:HIGH 7e-3"; CHR$(13); CHR$(10)

REM Program test time for 3 seconds
PRINT #1, "SOURce:SAFEty:STEP4:DC:TIME 3"; CHR$(13); CHR$(10)

REM Program low current limit for 1mA
PRINT #1, "SOURce:SAFEty:STEP4:DC:LIMit:LOW 0.0010"; CHR$(13); CHR$(10)

REM Program Arc limit for 5 mA
PRINT #1, "SOURce:SAFEty:STEP4:DC:limit:ARC:LEVel 0.005"; CHR$(13); CHR$(10)

REM Program Arc Filter for 3-50
PRINT #1, "SOURce:SAFEty:STEP4:DC:limit:ARC:FILTER 50e3"; CHR$(13); CHR$(10)
```

```
REM Program ramp time for 2 seconds
PRINT #1, "SOURce:SAFEty:STEP4:DC:TIME:RAMP 2.0"; CHR$(13); CHR$(10)

REM Program dwell time for 1 seconds
PRINT #1, "SOURce:SAFEty:STEP4:DC:TIME:DWELL 1.0"; CHR$(13); CHR$(10)

REM Program channel 3 high and channel 1 off
PRINT #1, "SOURce:SAFEty:STEP4:DC:CHAN:HIGH (@1(3))"; CHR$(13); CHR$(10)
PRINT #1, "SOURce:SAFEty:STEP4:DC:CHAN:LOW (@1(0))"; CHR$(13); CHR$(10)

REM Program STEP 5 for IR Test
REM Program IR DC voltage for 100 V
PRINT #1, "SOURce:SAFEty:STEP5:IR:LEVel 100"; CHR$(13); CHR$(10)

REM Program low resitance limit for .4 Mohm
PRINT #1, "SOURce:SAFEty:STEP5:IR:LIMIT:LOW 400000"; CHR$(13); CHR$(10)

REM Program test time for 5 sec
PRINT #1, "SOURce:SAFEty:STEP5:IR:TIME 5"; CHR$(13); CHR$(10)

REM Program high resistance limit off
PRINT #1, "SOURce:SAFEty:STEP5:IR:LIMit:HIGH 0.000"; CHR$(13); CHR$(10)

REM Program ramp time off
PRINT #1, "SOURce:SAFEty:STEP5:IR:TIME:RAMP 0.0"; CHR$(13); CHR$(10)

REM Program STEP 6 for LC Test using UL 2601 Body Model

REM Program SET DEVICE FOR UL2601
PRINT #1, "SOURce:SAFEty:STEP6:LC:DEVICE UL2601"; CHR$(13); CHR$(10)

REM Program LINE FOR NORMAL
PRINT #1, "SOURce:SAFEty:STEP6:LC:LINE NOR"; CHR$(13); CHR$(10)

REM Program METER L - P
PRINT #1, "SOURce:SAFEty:STEP6:LC:METER L,P"; CHR$(13); CHR$(10)

REM Program GROUND SWITCH Open
PRINT #1, "SOURce:SAFEty:STEP6:LC:GSWITCH 0"; CHR$(13); CHR$(10)

REM Program HIGH LIMIT TO 2mA
PRINT #1, "SOURce:SAFEty:STEP6:LC:LIMIT:HIGH 2E-3"; CHR$(13); CHR$(10)

REM Program LOW LIMIT TO 0.2mA
PRINT #1, "SOURce:SAFEty:STEP6:LC:lIMIT:LOW 2E-4"; CHR$(13); CHR$(10)

REM Program TEST TIME TO 3 SEC
PRINT #1, "SOURce:SAFEty:STEP6:LC:TIME:TEST 3"; CHR$(13); CHR$(10)

REM Program POWER TO VOLTAGE HIGH LIMIT 130
PRINT #1, "SOURce:SAFEty:STEP6:LC:POWER:VOLTAGE:LIMIT:HIGH 130"; CHR$(13); CHR$(10)

REM Program POWER TO VOLTAGE LOW LIMIT 90
PRINT #1, "SOURce:SAFEty:STEP6:LC:POWER:VOLTAGE:LIMIT:LOW 90"; CHR$(13); CHR$(10)
```

```
REM Program STEP 7 for UL1950
REM SET DEVICE FOR UL1950
PRINT #1, "SOURce:SAFEty:STEP7:LC:DEVICE UL1950"; CHR$(13); CHR$(10)

REM Program LINE FOR Reverse
PRINT #1, "SOURce:SAFEty:STEP7:LC:LINE REV"; CHR$(13); CHR$(10)

REM Program METER L - G
PRINT #1, "SOURce:SAFEty:STEP7:LC:METER L,G"; CHR$(13); CHR$(10)

REM Program GROUND SWITCH Closed
PRINT #1, "SOURce:SAFEty:STEP7:LC:GSWITCH 1"; CHR$(13); CHR$(10)

REM Program HIGH LIMIT TO 10mA
PRINT #1, "SOURce:SAFEty:STEP7:LC:LIMIT:HIGH 10E-3"; CHR$(13); CHR$(10)

REM Program LOW LIMIT TO 1mA
PRINT #1, "SOURce:SAFEty:STEP7:LC:lIMIT:LOW 1E-3"; CHR$(13); CHR$(10)

REM Program TEST TIME TO 3 SEC
PRINT #1, "SOURce:SAFEty:STEP7:LC:TIME:TEST 3"; CHR$(13); CHR$(10)

REM Program POWER TO CURRENT HIGH LIMIT 20
PRINT #1, "SOURce:SAFEty:STEP7:LC:POWER:CURR:LIMIT:HIGH 20"; CHR$(13); CHR$(10)

REM Program POWER TO Current LOW LIMIT 2
PRINT #1, "SOURce:SAFEty:STEP7:LC:POWER:CURR:LIMIT:LOW 2"; CHR$(13); CHR$(10)

REM Program STEP 8 for UL544NP
REM SET DEVICE FOR UL544NP
PRINT #1, "SOURce:SAFEty:STEP8:LC:DEVICE UL544NP"; CHR$(13); CHR$(10)

REM Program LINE FOR Single Fault Normal
PRINT #1, "SOURce:SAFEty:STEP8:LC:LINE SFN"; CHR$(13); CHR$(10)

REM Program METER P1 - P2
PRINT #1, "SOURce:SAFEty:STEP8:LC:METER P,P"; CHR$(13); CHR$(10)

REM Program GROUND SWITCH OPEN
PRINT #1, "SOURce:SAFEty:STEP8:LC:GSWITCH 0"; CHR$(13); CHR$(10)

REM Program HIGH LIMIT TO 100uA
PRINT #1, "SOURce:SAFEty:STEP8:LC:LIMIT:HIGH 100E-6"; CHR$(13); CHR$(10)

REM Program LOW LIMIT TO 1uA
PRINT #1, "SOURce:SAFEty:STEP8:LC:lIMIT:LOW 1E-6"; CHR$(13); CHR$(10)

REM Program TEST TIME TO 3 SEC
PRINT #1, "SOURce:SAFEty:STEP8:LC:TIME:TEST 3"; CHR$(13); CHR$(10)

REM Program POWER TO VA HIGH LIMIT 2000
PRINT #1, "SOURce:SAFEty:STEP8:LC:POWER:VA:LIMIT:HIGH 2000"; CHR$(13); CHR$(10)
```

```
REM Program POWER TO VA LOW LIMIT 1000
PRINT #1, "SOURce:SAFEty:STEP8:LC:POWER:VA:LIMIT:LOW 1000"; CHR$(13); CHR$(10)

REM PROGRAM PRESET
REM PROGRAM PASS HOLD TO 0.5 SEC
PRINT #1, "SOUR:SAFE:PRESET:time:pass 0.5"; CHR$(13); CHR$(10)

REM PROGRAM STEP HOLD TO 1 SEC
PRINT #1, "SOUR:SAFE:PRESET:time:STEP 1"; CHR$(13); CHR$(10)

REM PROGRAM AC FREQ TO 100
PRINT #1, "SOUR:SAFE:PRESET:AC:FREQ 100"; CHR$(13); CHR$(10)

REM PROGRAM GB FREQ TO 50
PRINT #1, "SOUR:SAFE:PRESET:GB:FREQ 50"; CHR$(13); CHR$(10)

REM PROGRAM GB VOLTAGE TO 6
PRINT #1, "SOUR:SAFE:PRESET:GB:VOLT 6"; CHR$(13); CHR$(10)

REM PROGRAM IEC 601 ON
PRINT #1, "SOUR:SAFE:PRESET:IEC 1"; CHR$(13); CHR$(10)

REM PROGRAM SOFT AGC OFF
PRINT #1, "SOUR:SAFE:PRESET:AGC:SOFT 0"; CHR$(13); CHR$(10)

REM PROGRAM AUTO RANGE ON
PRINT #1, "SOUR:SAFE:PRESET:WRANGE:AUTO 1"; CHR$(13); CHR$(10)

REM FIND OUT HOW MANY STEPS TO LOOP FOR RESULTS
PRINT #1, "SOURce:SAFEty:SNUMBer?"; CHR$(13); CHR$(10)

INPUT #1, STEPNUM%
CLS
REM Start TEST
PRINT #1, "SOURce:SAFEty:STARt"; CHR$(13); CHR$(10)
PRINT " Testing"
REM Check status of the test
complete$ = "0"
WHILE complete$ <> "1"
     PRINT #1, "SOURce:SAFEty:RESult:COMPlete?"; CHR$(13); CHR$(10)
      INPUT #1, complete$
            CLS
      IF complete$ = "1" THEN
      '       PRINT #1, "SOURce:SAFEty:STOP"; CHR$(13); CHR$(10)

            REM Print Output voltage for each step
            PRINT #1, "SAFEty:RESult:ALL:OMET?"; CHR$(13); CHR$(10)

            FOR j = 1 TO STEPNUM%
            INPUT #1, RESult$
            PRINT "Measured Output Voltage:"
            PRINT "step", j, ":", RESult$
```

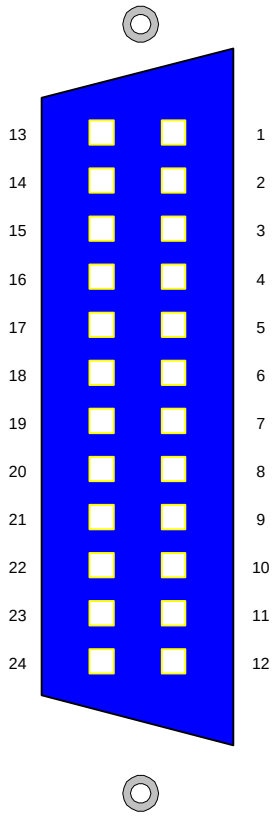
```
            NEXT j
            PRINT
            PRINT "************************************************"
            REM Print Measured result for each step
            PRINT #1, "SAFEty:RESult:ALL:MMET?"; CHR$(13); CHR$(10)
            FOR j = 1 TO STEPNUM%
                  INPUT #1, RESult$
                  PRINT "Measured Result:"
                  PRINT "step", j, ":", RESult$
            NEXT j
      END IF

WEND
CLOSE #1
END
```

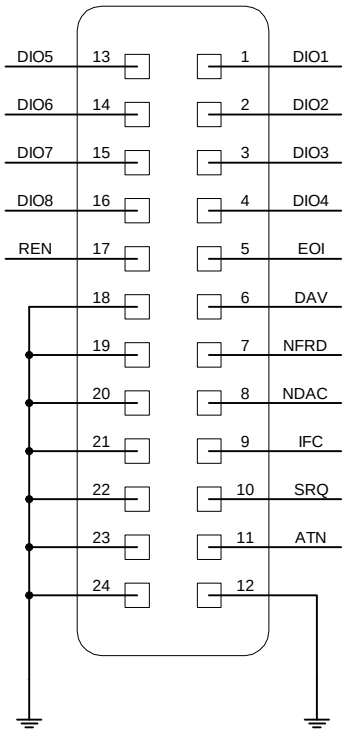
3.3 IEEE-488 Interface

3.3.1 PIN Configuration

An optional IEEE-488 interface is available for the Guardian 6100 Plus instrument. Connection through a blue 24-PIN connector (labeled GPIB) on the rear panel. This interface can be used to connect a system containing a number of instruments and a controller in which each meets IEEE Standard 488.2 (Standard Digital Interface for Programmable Instrumentation). Figure 3-6 illustrates the PIN Configuration of the IEEE-488 interface.



Guardian 6100 Plus
IEEE-488 Interface: Rear Panel View



Guardian 6100 Plus
IEEE-488 Interface: PIN Configuration

Figure 3-6: IEEE-488 Interface PIN Configuration

Table 3-1: IEEE-488 Interface Pin Designations

Signal Name	Pin Number	Function
DAV	6	Low State: "Data is Available" and valid on DI01 through DI08
NRFD	7	Low State: At least one Listener on the bus is "Not Ready For Data"
NDAC	8	Low State: At least one Listener on the bus is "Not Accepting Data"
ATN	11	"Attention" specifies 1 of 2 uses for the DI01 through DI08 lines: Low State: Controller command messages High State: Data bytes from the Talker device
IFC	9	"Interface Clear" Low State: Returns portion of interface system to a known quiescent state
SRQ	10	"Service Request" Low State: A Talker or Listener signals (to the controller) need for attention in the midst of the current sequence of events.
REN	17	"Remote Enable" Low State: Enables each device to enter remote mode when addressed to listen. High State: All devices revert to Local control.
EOI	5	"End of Identify" If ATN is in HIGH state, then EOI LOW state indicates the end of a multiple-byte data transfer sequence. If ATN is in LOW state, then EOI LOW state indicates a parallel poll.
DI01	1	The 8-Line Data Bus. If ATN is in LOW state, then the bus conveys interface messages. If ATN is in HIGH state, then the bus conveys device-dependent messages. (Example: carries remote control commands from the controller or from a talker device)
DI02	2	
DI03	3	
DI04	4	
DI05	13	
DI06	14	
DI07	15	
DI08	16	

3.3.2 IEEE-488 Interface Codes and Messages

The IEEE-488 (GPIB) address is defined in the [OPTION] submenu by selecting [MENU] [2] and [GPIB]. Refer to paragraph 2.3.2.2.

The G6100 Plus unit is in a remote control status when the REMOTE LED is ON.

To switch to Local from Remote press the [LOCAL] function key, disabled by LLO message.

The only controls functional under Remote operation is [LOCAL], which switches to Local and [STOP] which resets the unit.

Table 3-2 defines the IEEE-488 interface codes and their function. Table 3-3 defines the IEEE-488 interface messages and their function.

Table 3-2 : IEEE-488 Interface Codes

Code	Function
SH1	Source Handshake
AH1	Acceptor Handshake
T4	Basic Talker Function
L4	Basic Listener Function
SR1	Service Request Function
RL1	All Remote/Local Function
PP0	No Parallel Poll Function
DC1	All Device Clear Function
DT0	Device Trigger Function
C0	No Controller Functions

Table 3-3: IEEE-488 Interface Messages

Interface Message	Function	Description
GTL	Go To Local	Switch unit to local
SDC	Selected Device Clear	Reset the unit
LLO	Local Lockout	Disables [LOCAL] switch to local
IFC	Interface Clear	Reset IEEE-488 bus interface

3.3.3 IEEE-488 Interface Commands

The interface function is controlled by ASCII commands which include:

{[command + parameter] ; [command + parameter] + ending code}

The length of the string is 128 characters. It is not necessary to input any sign or space between the command and parameter. Any two commands can be connected by "," and [Ending Code]. Ending Code can be any type in Table 3-4.

Table 3-4 : IEEE-488 Interface Ending Codes

Ending Code
LF
CR + LF
EOI
LF + EOI
CR + LF + EOI

NOTE
The data can be sent out by the IEEE-488 interface to achieve transfer function. The data command is {string message + ending code}. The ending codes are listed in Table 3-3.

3.3.3.1 IEEE-488 Register Assignments

Table 3-5 lists the bit assignments for the Summary and Event registers. The configuration of these registers is illustrated in Figure 3-7.

Table 3-5: Summary Status & Event Status Registers

Summary Status Register			Event Status Register		
Bit	Decimal Value	Use	Bit	Decimal Value	Use
0	1	Not Used	0	1	Operation Complete
1	2	Has Result	1	2	Not Used
2	4	Error/Event Queue	2	4	Query Error
3	8	Not Used	3	8	Device Error (No device contact)
4	16	Message Available	4	16	Execution Error (Over Range, etc.)
5	32	Summary Standard Event Status Register	5	32	Command Error (Syntax)
6	64	Request Service	6	64	Not Used
7	128	Not Used	7	128	Power ON

3.3.3.2 IEEE-488 Register Configuration

Figure 3-7 illustrates the configuration of the Summary (Status), Event and Enable Registers for the Guardian 6100 Plus IEEE-488 Interface.

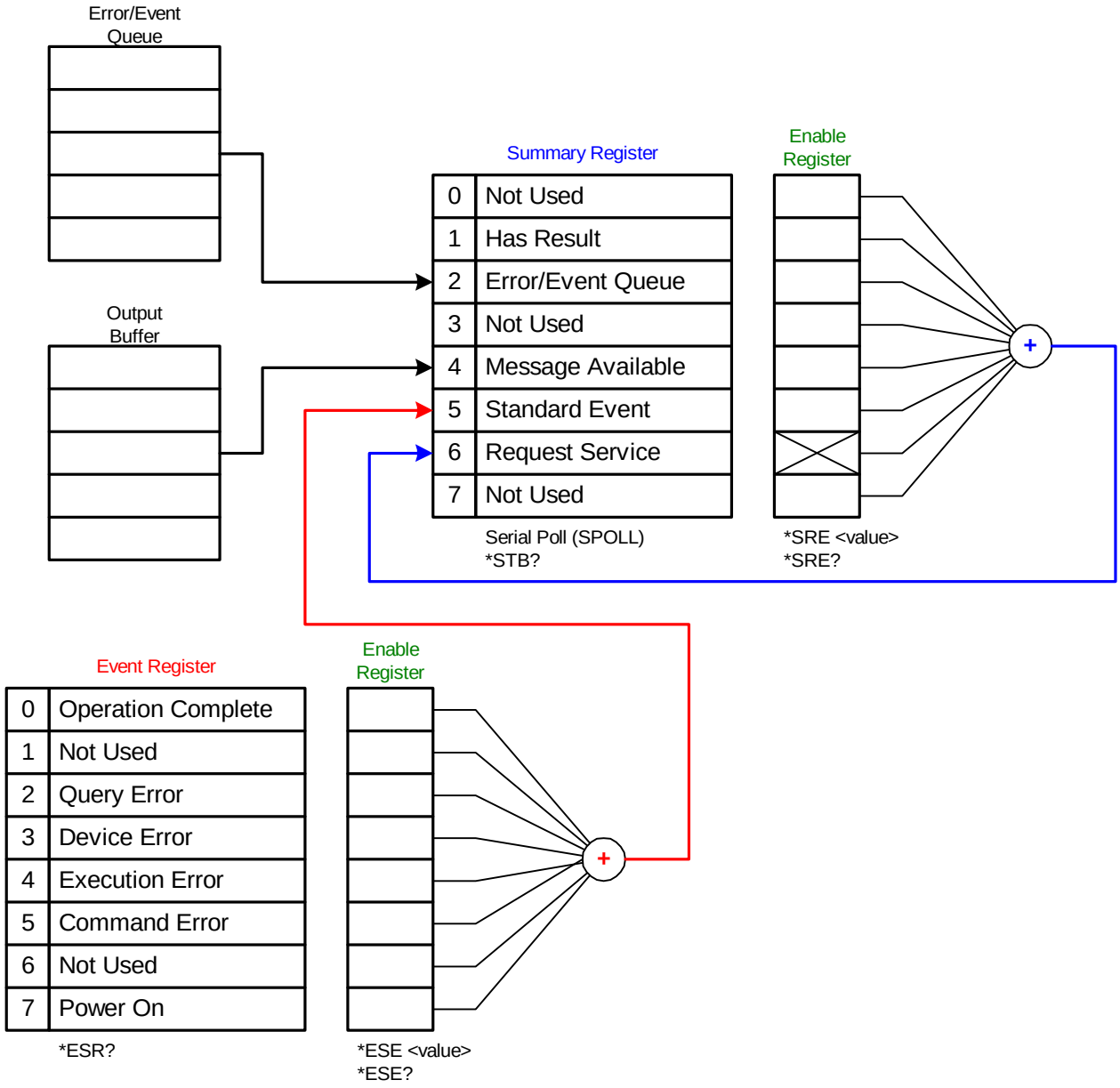


Figure 3-7: G6100 Plus IEEE-488 Register Configuration

Table 3-6: IEEE-488 Commands

Command	Name	Function	Output Format
*CLS	Clear Status	Clear standard event status register. Clear status bit group register except for bit 4 (MAV)	
*ESE	Event Status Enable	Enable standard event status register value.	0 – 255
*ESE?	Event Status Enable	Query standard event status of device enable register	0 – 255
*ESR?	Event Status Register	Query standard event register value of device. After this command, the standard register is cleared to 0.	0 – 255
*SRE	Service Request Enable	Enable service request register value.	0 – 255
*SRE?	Service Request Enable	Query/Read service request register value.	0 – 255
*STB?	Status Byte Register	Query/Read status byte register value	0 – 255
*OPC	Operation Complete	Operation is complete.	
*OPC?	Operation Complete	Query operation complete.	1
*PSC 0 | 1	Power On	Clear status of Power On	
*PSC?	Power On	Query Power On.	1 or 0
*IDN?	Identification	Query/Read basic device data. (A comma separates the identification fields.)	4 ID: Manufacturer, Device Model, Serial Number, Firmware Version
*SAV	Save	Save current status to memory.	1 – 100
*RCL	Recall	Recall saved status from memory.	1 – 100

3.3.4 IEEE-488 & SCPI Command Summary

The SCPI (Standard Commands for Programmable Instruments) parameter syntax format is listed on the following pages. To illustrate the order of precedence, the entire command list is scrolled through. The dual arrow symbol "<>" denotes the defined parameter is a standard SCPI command. The symbol "<numerical value>" denotes the metric system value. The symbol "<boolean>" denotes the Boolean equation data and its value is 0 or 1. The vertical line "|" denotes the OR parameter. When sending the G6100 Plus unit a decimal number it is necessary to have a zero before the decimal point. Example: DC: LIMit: HIGH: 0.004

:SYSTem

:VERSion?
Command: :SYSTem : VERSion?
This command queries the SCPI version of this device.

:ERRor
Command: :SYSTem : ERRor?
This command reads the message in the Error Queue.
Refer to paragraph 3.3.5 for Error Messages

:LOCk

:REQuest?1
Command: :SYSTem : LOCk : REQuest?1
This command locks the front panel (disables start from front panel).

:RELease
Command: :SYSTem : LOCk : RELease
This command unlocks the front panel (enables start from front panel).

:KLOCk1
Command: :SYSTem : KLOCk1
This command locks local controls.

:MEMory

:STATe

:NAME <name>
Command: :MEMory : STATe : DEFine: NAME: LOCATION
This command saves setup with name and location.

:LABEl <register name>
Command: :MEMory : STATe : LABEl ? <register number>
This command queries the memory location name.
Note: if location name is ABC, response is "ABC". If no location name, response is "".

:DELete

:NAME <name>
Command: :MEMory : DELete : NAME
This command deletes the data in main memory under defined name.

:FREE

:STEP?

Command: MEMory : FREE : STEP?

This command queries the next free step in main memory.

:PRESet?

Command: :MEMory : FREE : PRESet?

This command queries the next free preset number in main memory.

:SOURce

:SAFEty

:STARt

Command: :SOURce : SAFEty : STARt

This command starts the test.

:CSTANDARD

Command: :SOURce : SAFEty : STARt : CSTANDARD

This command triggers the G6000Plus to get the Cs value.

Known good DUT must be connected when this command is sent.

:OFFSet GET | OFF

Command: :SOURce : SAFEty : STARt : OFFSet GET

This command gets the offset value.

Command: : SOURce : SAFEty : STARt : OFFSet OFF

This command turns the offset function off.

:OFFSet?

Command: : SOURce : SAFEty : STARt : OFFSet?

This command queries if the offset function is ON or OFF.

:FETCh?

Command: [:SOURce] : SAFEty : FETCh? [<item>] [,<item>]

This command queries the data for the current test.

Example: :SOURce : SAFEty : FETCh? step,mode,omet,mmet,tela

The return string: 1;AC;+1.000000E+03; +4.000000E-05;+6.900002E+00

Item	Responding Data
STEP	The step number
MODE	The test mode
OMETerage	The output value
MMETerage	The measured value
RELApsed	The RAMP elapsed time
RLEAve	The time left in the RAMP cycle
TELApsed	The elapsed TEST time
TLEAve	The time left in the TEST cycle

:STOP

Command: :SOURce : SAFEty : STOP

This command stops the test.

:STATus?

Command: :SOURce : SAFEty : STATus?

This command queries the execution status of the current device under test.

The return character data is RUNNING | STOPPED

:RESult

:ALL

:JUDGment?

Command: :SOURce : SAFEty : RESult : ALL : JUDGment?

This command queries all the judgment results. The return format is:

PASS	74	116
USER STOP	71	113
CAN NOT TEST	72	114
TESTING	73	115
STOP	70	112

HEX and DEC values:

	GB MODE		AC MODE		DC MODE		IR MODE	
	HEX	DEC	HEX	DEC	HEX	DEC	HEX	DEC
HI	11	17	21	33	31	49	41	65
LO	12	18	22	34	32	50	42	66
ARC	---	---	23	35	33	51	---	---
IO	---	---	24	36	34	52	---	---
ADV OVER	16	22	26	38	36	54	46	70
ADI OVER	17	23	27	39	37	55	47	71

OSC SHORT (DEC) = 103; OSC OPEN (DEC) = 98

:OMETerage?

Command: :SOURce : SAFEty : RESult : ALL : OMETerage?

This command queries all the voltage (output meter) readings for the step.

:MMETerage?

Command: :SOURce : SAFEty : RESult : ALL : MMETerage?

This command queries all the Measure Meter readings for the step.

:TIME :TEST?

Command: :SOURce : SAFEty : RESult : ALL : TIME : TEST?

This command reads back all step test times including failure times.

:LAST :JUDGment?

Command: :SOURce : SAFEty : RESult : LAST : JUDGment?

This command queries status while testing.

:RESult

:COMPleted?

Command: :SOURce : SAFEty : RESult : COMPlete?

This command queries if all the test results are completed.

The return format is a “1” or a “0”.

:AREPort <Boolean> ON | OFF (RS232 Interface only)

Command: :SOURce : SAFEty : RESult : AREPort

This command sets the Automatic Reporting of the test results.

:AREPort ? (RS232 Interface only)
Command: :SOURce : SAFEty : RESult : AREPort?
This command queries if the Automatic Reporting of test results is ON or OFF.
The return format is a “1” or a “0”.
:SNUMber?
Command: :SOURce : SAFEty : SNUMber?
This command queries the step number being set in memory.

:STEP <n>

:DELete
Command: :SOURce : SAFEty : STEP : DELete
This command clears all setting values in selected step to the initial value.
<n> denotes the step number. Range: $1 \leq n \leq 99$.
:SET?
Command: :SOURce : SAFEty : STEP : SET?
This command queries all setting values in selected step.
:MODE?
Command: :SOURce : SAFEty : STEP <n> : MODE?
This command queries the test Mode of the selected step.
The return format is: GB | AC | DC | IR | OSC | PA | LC.

:AC
:LEVel <numeric value>
Command: :SOURce : SAFEty : STEP <n> : AC : LEVEL
This command sets the AC voltage level for the selected step.
<numeric value> is 50 to 5000 and the unit is volts.
:LEVel?
Command: :SOURce : SAFEty : STEP <n> : AC : LEVEL?
This command queries the AC voltage level for the selected step.
The return format is a numerical value: $50 \leq \text{value} \leq 5000$ volts.

:LIMit

:HIGH <numeric value>
Command: :SOURce : SAFEty : STEP <n> : AC : LIMit : HIGH
This command sets the high current limit for the selected step.
<numeric value> is 0.000001 to 0.030 and the unit is amps.
:HIGH?
Command: :SOURce : SAFEty : STEP <n> : AC : LIMit : HIGH?
This command queries the high current limit for the selected step.
:LOW <numeric value>
Command: :SOURce : SAFEty : STEP <n> : AC : LIMit : LOW
This command sets the low current limit for the selected step.
<numeric value> is 0 to 0.030 and the unit is amps. 0 = OFF
:LOW?
Command: :SOURce : SAFEty : STEP <n> : AC : LIMit : LOW?
This command queries the low current limit for the selected step.

:ARC <numeric value>
Command: :SOURce : SAFEty : STEP <n> : AC : LIMit : ARC
This command sets the arc current limit for the selected step.
<numeric value> is 0 to 0.030 and the unit is amps. 0 = OFF
:ARC?
Command: :SOURce : SAFEty : STEP <n> : AC : LIMit : ARC?
This command queries the arc current limit for the selected step.
:ARC:FILTER <numeric value>
Command: :SOURce : SAFEty : STEP <n> : AC : LIMit : ARC FILTER
This command sets the arc filter for the selected step.
<numeric value> is 23e3, 50e3, 100e3 or 230e3 and the unit is Hz.
:ARC FILTER?
Command: :SOURce : SAFEty : STEP <n> : AC : LIMit : ARC FILTER?
This command queries the arc filter for the selected step.

:TIME
:RAMP <numeric value>
Command: :SOURce : SAFEty : STEP <n> : AC : TIME : RAMP
This command sets the ramp time for the selected step.
<numeric value> is 0, 0.1 to 999 and the unit is seconds. 0 = OFF
:RAMP?
Command: :SOURce : SAFEty : STEP <n> : AC : TIME : RAMP?
This command queries the ramp time for the selected step.
:TEST <numeric value>
Command: :SOURce : SAFEty : STEP <n> : AC : TIME : TEST
This command sets the test time for the selected step.
<numeric value> is 0, 0.3 to 999 and the unit is seconds. 0 = OFF
:TEST?
Command: :SOURce : SAFEty : STEP <n> : AC : TIME : TEST?
This command queries the test time for the selected step.

:CHANnel (@ <Box#> (<channel list>))
:HIGH <channel list>
Command: :SOURce : SAFEty : STEP <n> : AC : CHAN : HIGH (@ Box# (<channel list>))
This command sets the high scan channels for the selected step.
:HIGH?
Command: :SOURce : SAFEty : STEP <n> : AC : CHAN : HIGH?
This command queries the high scan channels for the selected step.

:LOW <channel list>
Command: :SOURce : SAFEty : STEP <n> : AC : CHAN : LOW (@ Box# (<channel list>))
This command sets the low scan channels for the selected step.
:LOW?
Command: :SOURce : SAFEty : STEP <n> : AC : CHAN : LOW?
This command queries the low scan channels for the selected step.

Example: The command :SOUR : SAFE : STEP 1 : AC : CHAN : HIGH (@ 1 (1:4))
Sets Channels 1 through 4 HIGH.

Note: Channel list must be 0 (zero) when no channels are set high or low.

:DC

:LEVel <numeric value>
Command: :SOURce : SAFEty : STEP <n> : DC : LEVEL
This command sets the DC voltage level for the selected step.
<numeric value> is 50 to 6000 and the unit is volts.
:LEVel?
Command: :SOURce : SAFEty : STEP <n> : DC : LEVEL?
This command queries the AC voltage level for the selected step.
The return format is a numerical value: 50 ≤ value ≤ 6000 volts.
:LIMit

:HIGH <numeric value>
Command: :SOURce : SAFEty : STEP <n> : DC : LIMit : HIGH
This command sets the high current limit for the selected step.
<numeric value> is 0.0000001 to 0.010 and the unit is amps.
:HIGH?
Command: :SOURce : SAFEty : STEP <n> : DC : LIMit : HIGH?
This command queries the high current limit for the selected step.
:LOW <numeric value>
Command: :SOURce : SAFEty : STEP <n> : DC : LIMit : LOW
This command sets the low current limit for the selected step.
<numeric value> is 0 to 0.010 and the unit is amps. 0 = OFF
:LOW?
Command: :SOURce : SAFEty : STEP <n> : DC : LIMit : LOW?
This command queries the low current limit for the selected step.
:ARC <numeric value>
Command: :SOURce : SAFEty : STEP <n>: DC : LIMit : ARC
This command sets the arc current limit for the selected step.
<numeric value> is 0 to 0.010 and the unit is amps. 0 = OFF
:ARC?
Command: :SOURce : SAFEty : STEP <n> : DC : LIMit : ARC?
This command queries the arc current limit for the selected step.

:ARC:FILTER <numeric value>

Command: :SOURce : SAFEty : STEP <n> : DC : LIMit : ARC FILTER

This command sets the arc filter for the selected step.

<numeric value> is 23e3, 50e3, 100e3 or 230e3 and the unit is Hz.

:ARC FILTER?

Command: :SOURce : SAFEty : STEP <n> : DC : LIMit : ARC FILTER?

This command queries the arc filter for the selected step.

:TIME

:RAMP <numeric value>

Command: :SOURce : SAFEty : STEP <n> : DC : TIME : RAMP

This command sets the ramp time for the selected step.

<numeric value> is 0 to 999 and the unit is seconds. 0 = OFF

:RAMP?

Command: :SOURce : SAFEty : STEP <n> : DC : TIME : RAMP?

This command queries the ramp time for the selected step.

:DWEL? <numeric value>

Command: :SOURce : SAFEty : STEP <n> : DC : TIME : DWEL?

This command sets the dwell time for the selected step.

<numeric value> is 0 to 999 and the unit is seconds. 0 = OFF

:DWEL?

Command: :SOURce : SAFEty : STEP <n> : DC : TIME : DWEL?

This command queries the dwell time for the selected step.

:TEST <numeric value>

Command: :SOURce : SAFEty : STEP <n> : DC : TIME : TEST

This command sets the test time for the selected step.

<numeric value> is 0, 0.3 to 999 and the unit is seconds. 0 = Continuous

:TEST?

Command: :SOURce : SAFEty : STEP <n> : DC : TIME : TEST?

This command queries the test time for the selected step.

:CHANnel (@ <Box#> (<channel list>))

:HIGH <channel list>

Command: :SOURce : SAFEty : STEP <n> : DC : CHAN : HIGH (@Box# (<channel list>))

This command sets the high scan channels for the selected step.

:HIGH?

Command: :SOURce : SAFEty : STEP <n> : DC : CHAN : HIGH?

This command queries the high scan channels for the selected step.

:LOW <channel list>
Command: :SOURce : SAFEty : STEP <n> : DC : CHAN : LOW (@Box#(<channel list>))
This command sets the low scan channels for the selected step.
:LOW?
Command: :SOURce : SAFEty : STEP <n> : DC : CHAN : LOW?
This command queries the low scan channels for the selected step.

Note: Channel list must be 0 (zero) when no channels are set high or low.

:IR
:LEVel <numeric value>
Command: :SOURce : SAFEty : STEP <n> : IR : LEVEL
This command sets the DC voltage level for the selected step.
<numeric value> is 50 to 1000 and the unit is volts.
:LEVel?
Command: :SOURce : SAFEty : STEP <n> : IR : LEVEL?
This command queries the AC voltage level for the selected step.
The return format is a numerical value: 50 ≤ value ≤ 1000 volts.
:LIMit
:HIGH <numeric value>
Command: :SOURce : SAFEty : STEP <n> : IR : LIMit : HIGH
This command sets the high resistance limit for the selected step.
<numeric value> is 0 to 50G and the unit is ohms. 0 = OFF
:HIGH?
Command: :SOURce : SAFEty : STEP <n> : IR : LIMit : HIGH?
This command queries the high current limit for the selected step.
:LOW <numeric value>
Command: :SOURce : SAFEty : STEP <n> : IR : LIMit : LOW
This command sets the low resistance limit for the selected step.
<numeric value> is 0.1 to 50000M and the unit is ohms.
:LOW?
Command: :SOURce : SAFEty : STEP <n> : IR : LIMit : LOW?
This command queries the low current limit for the selected step.
:TIME
:RAMP <numeric value>
Command: :SOURce : SAFEty : STEP <n> : IR : TIME : RAMP
This command sets the ramp time for the selected step.
<numeric value> is 0 to 999 and the unit is seconds. 0 = OFF
:RAMP?
Command: :SOURce : SAFEty : STEP <n> : IR : TIME : RAMP?
This command queries the ramp time for the selected step.

:TEST <numeric value>
Command: :SOURce : SAFEty : STEP <n> : IR : TIME : TEST
This command sets the test time for the selected step.
<numeric value> is 0, 0.3 to 999 and the unit is seconds. 0 = Continuous
:TEST?
Command: :SOURce : SAFEty : STEP <n> : IR : TIME : TEST?
This command queries the test time for the selected step.

:CHANnel (@ <Box#> (<channel list>))
:HIGH <channel list>
Command: :SOURce : SAFEty : STEP <n> : IR : CHAN : HIGH (@ Box# (<channel list>))
This command sets the high scan channels for the selected step.
:HIGH?
Command: :SOURce : SAFEty : STEP <n> : IR : CHAN : HIGH?
This command queries the high scan channels for the selected step.
:LOW <channel list>
Command: :SOURce : SAFEty : STEP <n> : IR : CHAN : LOW (@ Box# (<channel list>))
This command sets the low scan channels for the selected step.
:LOW?
Command: :SOURce : SAFEty : STEP <n> : IR : CHAN : LOW?
This command queries the low scan channels for the selected step.

Note: Channel list must be 0 (zero) when no channels are set high or low.

:GB
:LEVel <numeric value>
Command: :SOURce:SAFEty:STEP<n>:GB:LEVel <numeric value>
This command sets the DC voltage level for the selected step.
<numeric value> is 3 to 30 (40 w/option) and the unit is amperes.
:LEVel?
Command: :SOURce:SAFEty:STEP<n>:GB:LEVel?
This command queries the current level for the selected step.
:LIMit
:LIMit:HIGH <numeric value>
Command: :SOURce:SAFEty:STEP<n>:GB:LIMit:HIGH <numeric value>
This command sets the high resistance limit for the selected step.
<numeric value> is 0 to 510 and the unit is milliohms
:LIMit:HIGH?
Command: :SOURce:SAFEty:STEP<n>:GB:LIMit:HIGH?
Return Value: +1.000000E-03
This command queries the high resistance limit for the selected step

:LIMit:LOW <numeric value>
Command: :SOURce:SAFEty:STEP<n>:GB:LIMit:LOW <numeric value>
This command sets the low resistance limit for the selected step.
<numeric value> is 0 to 100 and the unit is milliohms.
:LIMit:LOW?
Command: :SOURce:SAFEty:STEP<n>:GB:LIMit:LOW?
Return Value: +1.000000E-02
This command queries the low resistance limit for the selected step.

:TIME

:TEST <numeric value>
Command: :SOURce:SAFEty:STEP <n>:GB:TIME:TEST <numeric value>
This command sets the test time for the selected step.
<numeric value> is 0 to 999 and the unit is seconds.
:TIME:TEST?
Command: :SOURce:SAFEty:STEP <n>:GB:TIME:TEST?
Return Value: +6.000000E+01 (for 60 second test)
This command queries the test time for the selected step.

:TPORT

:TPORT 1|0
Command: :SOURce:SAFEty:STEP<n>:GB:TPORT
This command enables or disables Twin Port
Valid commands are ON or OFF 1 or 0
:TPORT?
Command: :SOURce:SAFEty:STEO<n>:GB:TPORT?
This command queries the status of Twin Port

:CHANnel (@<Box#>(<channel list>)

:HIGH <channel list>
Command: :SOURce:SAFEty:STEP<n>:GB:CHAN:HIGH(@<Box#>(<channel list>)
This command sets the high scan channels for the selected step
:HIGH?
Command: :SOURce:SAFEty:STEP<n>:GB:CHAN:HIGH?
This command queries the high scan channels for the selected step

:OSC

:LIMIT

:OPEN <numeric value>
Command: :SOURce:SAFEty:STEP<n>:OSC:LIMIT:OPEN
This command sets the Open circuit percentage
<numeric value> 0.5 to 1 (0.5 = 50%)

:SHORT <numeric value>
Command: :SOURce:SAFEty:STEP<n>:OSC:LIMIT:SHORT
This command sets the Short circuit percentage
<numeric value> 0, 1 – 5 (1 = 100%, 5 = 500%)

:LC

:DEVice

Command: :SOURce:SAFEty:STEP<n>:LC:DEVice

This command sets the circuit model for the selected step.

UL1950 | UL 1563 | UL544NP | UL544P | UL2601

:DEVice?

Command: :SOURce:SAFEty:STEP<n>:LC:DEVice?

This command queries the circuit model for the selected step.

:LINE

Command: :SOURce:SAFEty:STEP<n>:LC:LINE

This command sets the line input for the selected step.

NORmal | REVerse | SFNormal | SFReverse

:LINE?

Command: :SOURce:SAFEty:STEP<n>:LC:LINE?

This command queries the line input for the selected step.

:METEr

Command: :SOURce:SAFEty:STEP<n>:LC:METEr

This command sets the measurement point for the selected step.

:METEr?

Command: :SOURce:SAFEty:STEP<n>:LC:METEr?

This command queries the measurement point for the selected step.

Return: L,G | L,P | P,P

:GSWItch <boolean> 1 | 0

Command: :SOURce:SAFEty:STEP<n>:LC:GSWItch

This command sets the ground switch for the selected step.

:GSWItch?

Command: :SOURce:SAFEty:STEP<n>:LC:GSWItch?

This command queries the ground switch for the selected step.

Return: 1 | 0 1 = ON = Open; 0 = OFF = Closed

:LIMit

:LIMit[:HIGH] <numeric value>

Command: :SOURce:SAFEty:STEP<n>:LC:LIMit[:HIGH] <numeric value>

This command sets the high current limit for the selected step.

<numeric value> is 0 to 10 and the unit is amps

:LIMit[:HIGH]?

Command: :SOURce:SAFEty:STEP<n>:LC:LIMit[:HIGH]?

Return Value: +1.000000E-03

This command queries the high current limit for the selected step

:LIMit:LOW <numeric value>
Command: :SOURce:SAFEty:STEP<n>:LC:LIMit:LOW <numeric value>
This command sets the low current limit for the selected step.
<numeric value> is 0 to 10 and the unit is amps.
:LIMit:LOW?
Command: :SOURce:SAFEty:STEP<n>:LC:LIMit:LOW?
Return Value: +1.000000E-02
This command queries the low current limit for the selected step.

:TIME
[:TEST]<numeric value>
Command: :SOURce:SAFEty:STEP <n>:LC:TIME[:TEST] <numeric value>
This command sets the test time for the selected step.
<numeric value> is 0 to 999 and the unit is seconds.
[:TEST]?
Command: :SOURce:SAFEty:STEP <n>:LC:TIME[:TEST]?
Return Value: +6.000000E+01 (for 60 second test)
This command queries the test time for the selected step.

:POWer
:MODE?
Command: :SOURce:SAFEty:STEP <n>:LC:POWer:MODE?
Return: VOLTAGE | CURRENT | VA | SOURCE
This command queries the power measurement mode for the selected step.
:VOLTage
Command: :SOURce:SAFEty:STEP <n>:LC:POWer:VOLTage
This command sets the power measurement to voltage for the selected step.
:LIMit[:HIGH] <numeric value>
Command: :SOURce:SAFEty:STEP<n>:LC:POWer:VOLTage[:LIMit][:HIGH]<nv>
This command sets the high power limit for the selected step.
<numeric value> is 0 to 300 and the unit is volts
:LIMit[:HIGH]?
Command: :SOURce:SAFEty:STEP<n>:LC: POWer:VOLTage[:LIMit][:HIGH]?
This command queries the high power limit for the selected step
The return format is a numerical value: 0 ≤ value ≤ 300V
:LIMit:LOW <numeric value>
Command: :SOURce:SAFEty:STEP<n>:LC: POWer:VOLTage[:LIMit]:LOW <nv>
This command sets the low power limit for the selected step.
<numeric value> is 0 to 300 and the unit is volts.
:LIMit:LOW?
Command: :SOURce:SAFEty:STEP<n>:LC: POWer:VOLTage[:LIMit]:LOW?
This command queries the low power limit for the selected step
The return format is a numerical value: 0 ≤ value ≤ 300V, 0 = OFF

:CURRent

Command: :SOURce:SAFEty:STEP <n>:LC:POWer:CURRent

This command sets the power measurement to current for the selected step.

:LIMit[:HIGH] <numeric value>

Command: :SOURce:SAFEty:STEP<n>:LC:POWer:CURRent[:LIMit][:HIGH]<nv>

This command sets the high power limit for the selected step.

<numeric value> is 0 to 20 and the unit is amps

:LIMit[:HIGH[?

Command: :SOURce:SAFEty:STEP<n>:LC: POWer:CURRent[:LIMit][:HIGH]?

This command queries the high power limit for the selected step

The return format is a numerical value: 0 ≤ value ≤ 20A

:LIMit:LOW <numeric value>

Command: :SOURce:SAFEty:STEP<n>:LC: POWer:CURRent[:LIMit]:LOW <nv>

This command sets the low power limit for the selected step.

<numeric value> is 0 to 20 and the unit is amps.

:LIMit:LOW?

Command: :SOURce:SAFEty:STEP<n>:LC: POWer:CURRent[:LIMit]:LOW?

This command queries the low power limit for the selected step

The return format is a numerical value: 0 ≤ value ≤ 20A, 0 = OFF

:VA

Command: :SOURce:SAFEty:STEP <n>:LC:POWer:VA

This command sets the power measurement to volt-amps for the selected step.

:LIMit[:HIGH] <numeric value>

Command: :SOURce:SAFEty:STEP<n>:LC:POWer:VA[:LIMit][:HIGH]<nv>

This command sets the high power limit for the selected step.

<numeric value> is 0 to 4400 and the unit is volt-amperes

:LIMit[:HIGH]?

Command: :SOURce:SAFEty:STEP<n>:LC: POWer:VA[:LIMit][:HIGH]?

This command queries the high power limit for the selected step

The return format is a numerical value: 0 ≤ value ≤ 4400VA

:LIMit:LOW <numeric value>

Command: :SOURce:SAFEty:STEP<n>:LC: POWer:VA[:LIMit]:LOW <nv>

This command sets the low power limit for the selected step.

<numeric value> is 0 to 4400 and the unit is volt-amperes.

:LIMit:LOW?

Command: :SOURce:SAFEty:STEP<n>:LC: POWer:VA[:LIMit]:LOW?

This command queries the low power limit for the selected step

The return format is a numerical value: 0 ≤ value ≤ 4400VA, 0 = OFF

:SIMUlation

Command: :SOURce:SAFEty:STEP <n>:LC:POWer:SIMUlation

This command sets the power measurement to simulation for the selected step.

:SIMUlation:TVOLtage <numeric value>

Command: :SOURce:SAFEty:STEP<n>:LC:POWer:SIMUlation:TVOLtage <nv>

This command sets the target voltage for the selected step.

<numeric value> is 80 to 300 and the unit is volts

:SIMUlation:TVOLtage?

Command: :SOURce:SAFEty:STEP<n>:LC: POWer: SIMUlation:TVOLtage?

This command queries the target voltage for the selected step

The return format is a numerical value: 80 ≤ value ≤ 300V

:CHANnel[:LOW]

Command: :SOURce:SAFEty:STEP<n>:LC:CHANnel[:LOW] <channel list>

This command sets the Low (Return) channels for the selected step.

:CHANnel[:LOW]?

Command: :SOURce:SAFEty:STEP<n>:LC:CHANnel[:LOW]?

This command queries the Low (Return) channels for the selected step.

:PRESet

:TIME

:PASS <numerical value>

Command: :SOURce : SAFEty : PRESet : TIME : PASS

This command sets the time the remote I/O pass relay is closed when result is pass.

<numeric value> is a value between 0.2 and 99.9 and the unit is seconds.

:PASS?

Command: :SOURce : SAFEty : PRESet : TIME : PASS?

This command queries the set time the remote I/O pass relay is to be closed.

:STEP <numerical value> | KEY

Command: :SOURce : SAFEty : PRESet : TIME : STEP

This command sets the interval time between steps.

<numeric value> is a value or character key between 0.1 and 99.9 seconds.

:STEP?

Command: :SOURce : SAFEty : PRESet : TIME : STEP?

This command queries the interval time between tests.

:AC

:FREQuency <numerical value>

Command: :SOURce : SAFEty : PRESet : AC : FREQuency

This command sets the test frequency for AC Hipot Test.

<numeric value> is a value between 50 and 600 and the unit is Hz.

:FREQuency?

Command: :SOURce : SAFEty : PRESet : AC : FREQuency?

This command queries the test frequency for the AC Hipot Test.

:GB

:FREQuency <numerical value>

Command: :SOURce : SAFEty : PRESet : GB : FREQuency

This command sets the test frequency for GB Test.

<numeric value> is a value between 50 or 60 and the unit is Hz.

:FREQuency?

Command: :SOURce : SAFEty : PRESet : GB : FREQuency?

This command queries the test frequency for the GB Test.

:WRANge

:AUTO <boolean> ON|OFF

Command: :SOURce : SAFEty : PRESet : WRANge : AUTO

This command sets the Auto Range function ON or OFF.

<boolean value> is a “1” or a “0”.

:AUTO?

Command: :SOURce : SAFEty : PRESet : WRANge : AUTO?

This command queries the status of the Auto Range function.

The return value is a “1” or a “0”.

:AGC

:SOFTware <boolean> ON|OFF

Command: :SOURce : SAFEty : PRESet : AGC : SOFTware

This command sets the software Automatic Gain Control function ON or OFF.

<boolean value> is a “1” or a “0”.

:SOFTware?

Command: :SOURce : SAFEty : PRESet : AGC : SOFTware?

This command queries the status of the software Automatic Gain Control

The return value is a “1” or a “0”.

:NUMber

:PART <alpha-numeric value>

Command: :SOURce : SAFEty : PRESet : NUMber : PART

This command sets the part number for the device under test.

< alpha-numeric value > is a value of 0-9, A-Z and/or a-z.

:PART?

Command: :SOURce : SAFEty : PRESet : NUMber : PART?

This command queries the part number of the device under test.

:LOT < alpha-numeric value >

Command: :SOURce : SAFEty : PRESet : NUMber : LOT

This command sets the lot number for the device under test.

< alpha-numeric value > is a value of 0-9, A-Z and/or a-z.

:LOT?

Command: :SOURce : SAFEty : PRESet : NUMber : LOT?

This command queries the lot number of the device under test.

:SERIal <alpha-numeric value>
Command: :SOURce : SAFEty : PRESet : NUMber : SERIal
This command sets the serial number format.
<alpha-numeric value> is a value of 0-9, A-Z and/or a-z.
:SERIal?
Command: :SOURce : SAFEty : PRESet : NUMber : SERIal?
This command queries the serial number format.

3.3.5 Sample QuickBASIC Program

Refer to paragraph 3.2.4 for QuickBasic RS-232 program example.

3.4 Printer Interface

An optional Printer Interface (G38) is available for the Guardian 6100 Plus instrument. The Printer interface takes the place of the IEEE-488 interface and is factory installed when the unit is ordered. Connection is through the black 25-PIN connector labeled 'GPIB' on the rear panel of the G6100 Plus unit. Figure 3-8 illustrates the Printer interface PIN Configuration.

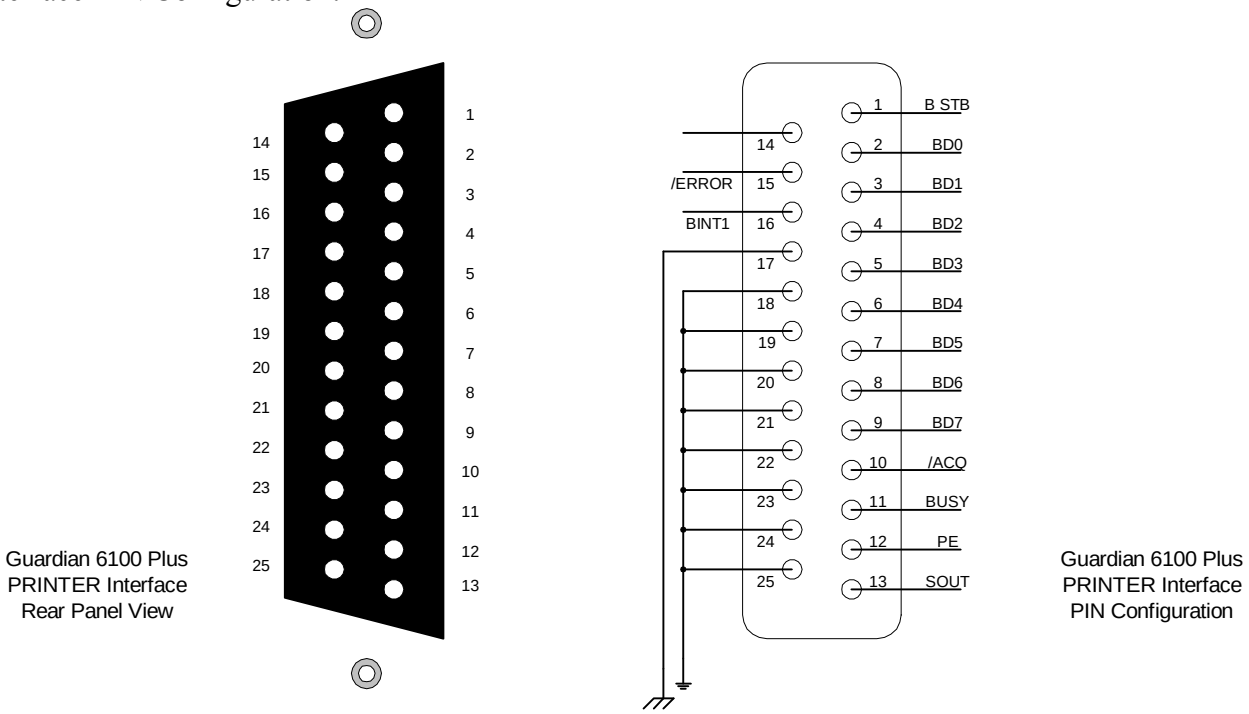


Figure 3-8: Printer Interface PIN Configuration

Example printer outputs for a 5-Step Test with Pass & Fail results are illustrated herein. The following printers have been tested with the G38 interface: Epson Stylus Color 440; Epson Stylus Color 460; Epson Stylus Photo 720; Epson LQ570C+ dot matrix; Epson LX300 and HP Deskjet 648C

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P/N: MX100
L/N: 542
SN: 54321678
Step-01 OSC   0.059  kV     0.161  nF     PASS
Step-02 GB    30.16  A      5.4    mO     PASS
Step-03 AC    1.199  kV     0.008  mA     PASS
Step-04 DC    1.502  kV     0.1    uA     PASS
Step-05 IR    0.500  kV     UUUU   GO     PASS
------------------------
------------------------
Step-01 OSC   0.059  kV     0.161  nF     PASS
Step-02 GB    27.54  A      UUUU   mO     ADIO
Step-03 AC    1.199  kV     0.008  mA     PASS
Step-04 DC    1.502  kV     0.1    uA     PASS
Step-05 IR    0.500  kV     UUUU   GO     PASS
2, 23 --FAIL
```

3.5 Scanner Interface

3.5.1 Scanner Accessories

The Scanner Interface is a standard accessory on the Guardian 6100 Plus instrument. Connection is through the black 25-PIN connector labeled 'SCAN' on the rear panel of the G6100 Plus instrument. The G6100 Plus unit has a standard internal 6000-07 scanner and may be used with an external scan unit for multi-point grounding and hipot tests. Table 3-7 displays the scanner accessories available for the G6100 Plus unit. Figure 3-9 illustrates the four external scanner options (P/N 5000-01, -02, -03 & -04).

Table 3-7 : Guardian 6100 Scanner Accessories

Item	Qty	QT P/N
25 pin interconnect cable (G6100 to Scanner)	1	G17
Hipot Test Lead Set (G6100 to Scanner I/P) HV plug to sheathed banana plug (red) Banana Plug (with retaining bracket) to sheathed banana plug (black)	 1 1	 G18 G19
Hipot Scan Clip Leads (Scanner to front panel outputs of DUT) Sheathed banana plug (orange) to alligator clip (red)	 8	 G21
GC Interconnect Cable (G6100 output to Scanner rear panel GC input) Banana plug/lug (red/black) to banana plug/lug (red/black)	 1	 G20*
GC Scan Clip Lead Set (Scanner rear panel GC outputs to DUT) Large alligator clips (red/black) to banana plug/lug (red/black)	 4	 G15*
External Scanner: 8 High Voltage Channels (Front)	1	5000-01
External Scanner: 8 High Voltage Channels (Front), 4GB Channels (Rear)	1	5000-02
External Scanner: 8 High Voltage Channels (Rear)	1	5000-03
External Scanner: 8 High Voltage Channels (Rear), 3GB Channels (Rear)	1	5000-04

* Included with GB Scanner only (5000-02, -04).

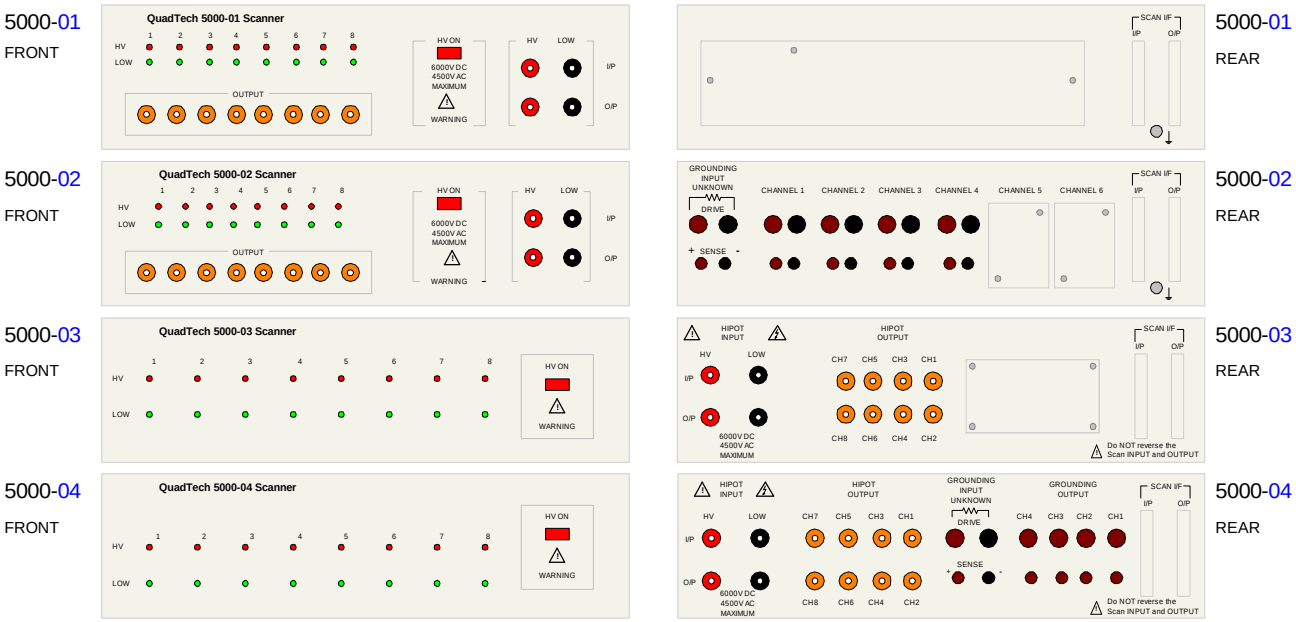

Figure 3-9: 5000-01, -02, -03 & -04 External Scanners

3.5.2 Scanner Connections

NOTE:
Connection to External Scanners (5000-01 to -04) should be made via the front panel outptut connectors of the G6100 Plus instrument.
The rear panel output connectors of the G6100 Plus are not identical to the front panel output connectors. The rear panel outptut of the G6100 Plus has a Floating Ground connection ("Ch-3" when programming internal scanner). Refer to p52, Figure 2-7.

Before connecting the scanner to the Guardian 6100 Plus or connecting devices for test, **press the [STOP] key** and make sure the red **DANGER** light is **OFF**. Figures 3-10 to 3-14 illustrate the setup and connection of the G6100 Plus to different scanners.

The G17 25-PIN SCAN control cable is connected from the G6100 Plus rear panel SCAN connector to the external scanner SCAN I/P connector. Refer to Figure 3-14.

The G18 lead set connects the HV terminals. The white 'Star' plug is connected to the G6100 Plus front panel HV output terminal and the red banana plug is connected to the external scanner HV I/P terminal. Refer to Figure 3-14.

The G19 lead set connects the GND terminals. The black banana plug with retaining bracket is connected to the G6100 Plus front panel GND output terminal and the black banana plug is connected to the external scanner LOW I/P terminal.

Interconnect the Rear Panel Ground Lugs (Chassis Ground, silver screw/banana plug) using a banana to banana cable or banana to spade cable. This assures that the scanner(s) retains connection to earth ground.

WARNING
THE REAR PANEL GROUND LUGS ON ALL INSTRUMENTS (Guardian 6100 Plus and Scanners) MUST BE INTERCONNECTED

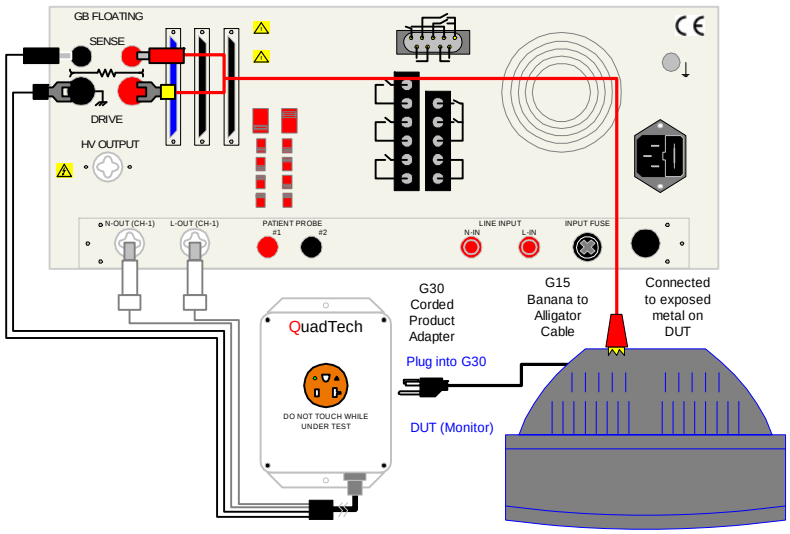

Figure 3-10: 6000-07 Scanner Connection to DUT for Hipot/IR

3.5.3 Programming the Internal Scanner

The 6100 Plus instrument is equipped with the internal 6000-07 "Hipot/Leakage Current" scanner. The 6000-07 internal scanner is designated Scanner #1. On Scanner #1, channels #1 and #3 can be programmed in the last step of an OSC, AC, DC, IR or LC test. Paragraphs 2.4.2, 2.4.3, 2.4.5, 2.4.6 and 2.4.7 illustrate how Scanner #1 is setup for each of these tests. Figure 3-11 illustrates the setup of Scanner #1 for an LC Test.

When in Scanner Setup, the numerical keypad serves as a toggle switch. For example, [1] corresponds to Channel 1 and when [1] is pressed the value of CH1 changes from "H" to "L" to "X". Press the numerical key that corresponds to the Channel # to set that channel's status. "H" signifies that the High Voltage/Current is applied to the selected channel. "L" signifies that the selected channel is the return and "X" denotes that the channel is not used.

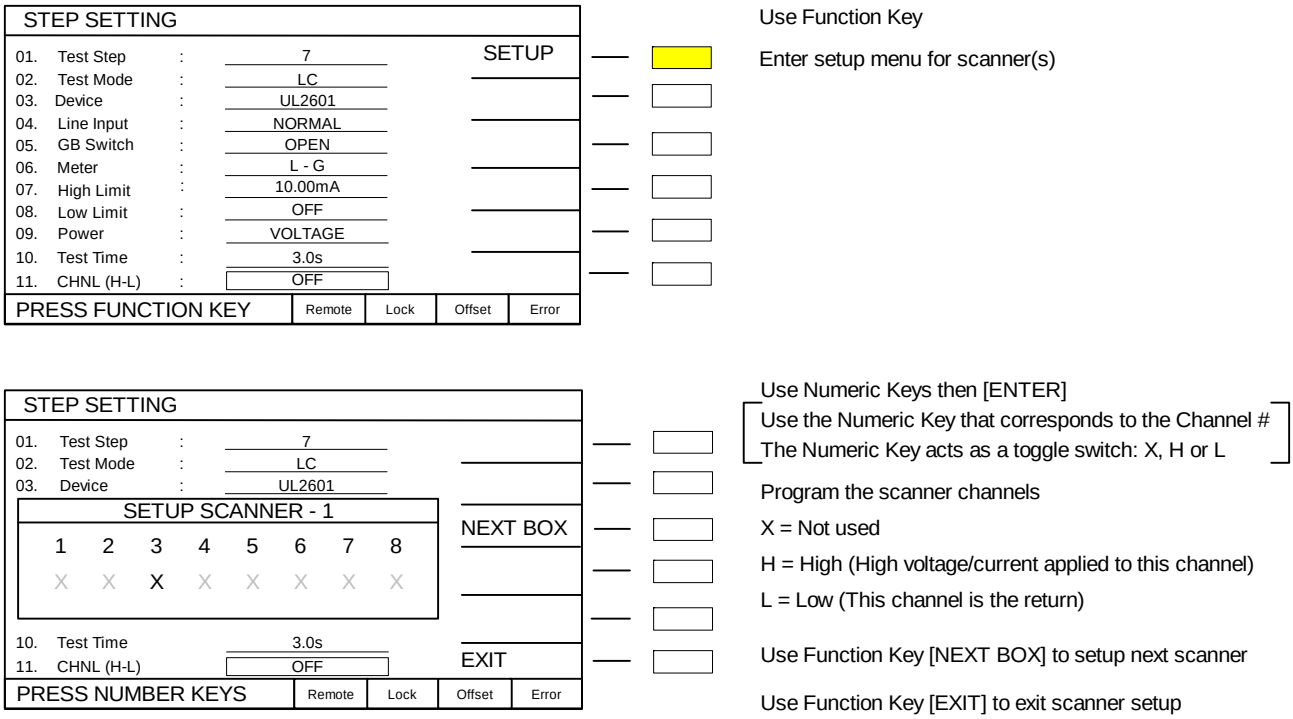

Figure 3-11: Scanner Programming Display: LC Mode

Scanner #1 is the internal 6000-07 Hipot/Leakage Current Scanner. In LC mode, Channels 1 and 3 are available on Scanner #1. CH1 is used to provide the voltage to the DUT to power it on. CH3 can be set to L or X.

NOTE: In the scanner setup menu, when the text appears ghost-like "X" with dashed lines it means that the channel is unavailable.

3.5.4 Programming an External Scanner

NOTE:
Connection to External Scanners (5000-01 to -04) should be made via the front panel outptut connectors of the G6100 Plus instrument.
The rear panel output connectors of the G6100 Plus are not identical to the front panel output connectors. The rear panel outptut of the G6100 Plus has a Floating Ground connection. Refer to p52, Figure 2-7.

NOTE:
When the scanner is programmed for multiple connections in the same test step the devices under test are connected in parallel. To test several devices independent from each other, requires an individual test step for each. Refer to ¶2.4 for step programming instructions.

The internal 6000-07 scanner is defined as Scanner-1. Scanner-2 is the first external scanner. Scannner-3 is the second external scanner. Up to 7 external scanners can be added for a total of 64 channels. When using more than one scanner, first setup the number of scanners connected to the G6100 Plus instrument. For this example there are two 5000-01 external scanners connected to the 6100 Plus instrument.

In MAIN MENU press [2] to enter the OPTION MENU.
Press [SCANNER]. To enter Scanner Setup
Display reads: "Scanner Type is: 6000-07"
Press the [↓] arrow so the backlit box is to the right of 'Select Scanner number:'.
Display reads: "Select Scanner Number: 1 "
Press the function key [UP] 2x to tell the 6100 Plus unit that there are 3 scanners in use.
Press [EXIT] to exit scanner setup.

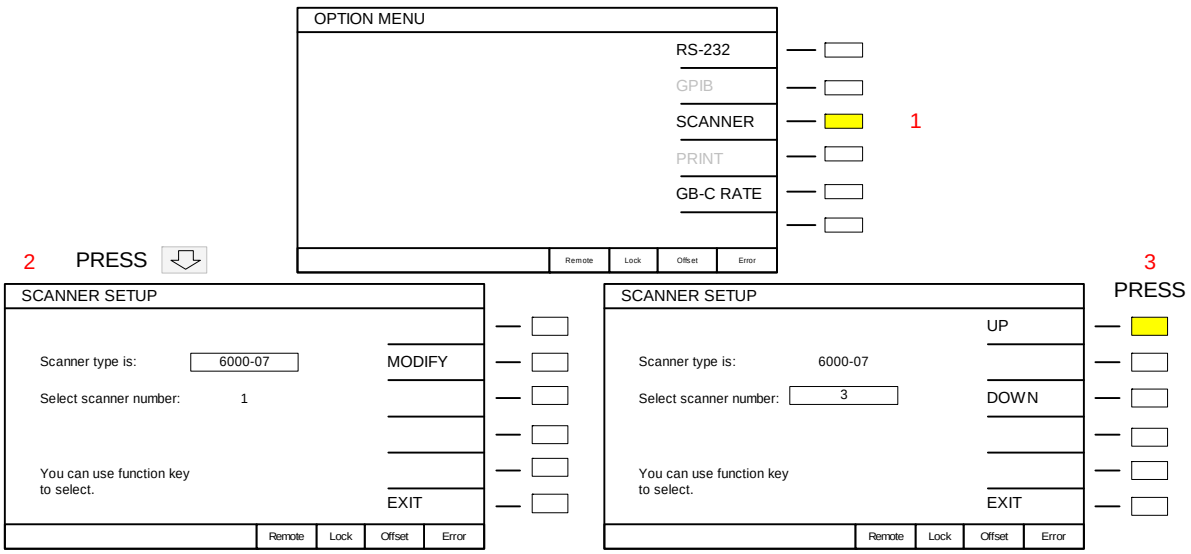

Figure 3-12: Scanner Number Setup

Program the Scanner Channels

Continuing the example, there are 4 DUTS connected to each of the 5000-01 external scanners as illustrated in Figure 3-13. The internal 6000-07 scanner is not used in this example. Program an OSC and an AC test and set CH1, 3, 5 & 7 to "L" and CH2, 4 6 & 8 to "H" for both Scanner #2 and #3.

In MAIN MENU press [PROGRAM] to enter the Program Menu. The backlit box is now again at the top of the list adjacent to "Test Step: [1] ".
Press DOWN arrow [⇓]
Press the function key [PAGE1/2] then [OSC] to select mode = Open/Short Circuit
Press DOWN arrow [⇓]
Press [5][0][ENTER] to set the Open Check = 50%
Press DOWN arrow [⇓]
Press [3][0][0][ENTER] to set the Short Check = 300%
Press DOWN arrow [⇓]
Display reads: "5. CHAN (H-L) : OFF"
Press the function key [SETUP]. Leave Scanner 1 OFF

Press the function key [NEXT BOX] to go to "Setup Scanner – 2"
Press [1] until L is selected.
Press [2] until H is selected.
Press [3] until L is selected.
Press [4] until H is selected.
Press [5] until L is selected.
Press [6] until H is selected.
Press [7] until L is selected.
Press [8] until H is selected.
Press the function key [NEXT BOX] to go to "Setup Scanner – 3"
Press [1] until L is selected.
Press [2] until H is selected.
Press [3] until L is selected.
Press [4] until H is selected.
Press [5] until L is selected.
Press [6] until H is selected.
Press [7] until L is selected.
Press [8] until H is selected.
Press the function key [EXIT]

Press DOWN arrow [⇓] The backlit box is now again at the top of the list adjacent to "Test Step: [1] ".
Press the function key [UP] to select Step # = 2
Press DOWN arrow [⇓]
Press the function key [AC] to select mode = AC Hipot
Press DOWN arrow [⇓]
Press [1][.][5][0][0][ENTER] to set voltage = 1.500kV (1500V)
Press DOWN arrow [⇓]
Press [0][.][5][0][0][ENTER] to set the high current limit = 0.500mA
Press DOWN arrow [⇓]
Press [0][ENTER] to set low current limit = OFF
Press DOWN arrow [⇓]
Press [0][ENTER] to set arc current limit = OFF
Press DOWN arrow [⇓]

Press the function key [3 -230 kHz] to set arc filter frequency = 3 – 230kHz
Press DOWN arrow [⇓]
Press [3][.][0][ENTER] to set test time = 3.0s
Press DOWN arrow [⇓]
Press [0][ENTER] to set ramp time = OFF
Press DOWN arrow [⇓]
Display reads: "10. CHAN (H-L) : OFF"
Press the function key [SETUP]. Leave Scanner 1 OFF

Press the function key [NEXT BOX] to go to "Setup Scanner – 2"
Press [1] until L is selected.
Press [2] until H is selected.
Press [3] until L is selected.
Press [4] until H is selected.
Press [5] until L is selected.
Press [6] until H is selected.
Press [7] until L is selected.
Press [8] until H is selected.
Press the function key [NEXT BOX] to go to "Setup Scanner – 3"
Press [1] until L is selected.
Press [2] until H is selected.
Press [3] until L is selected.
Press [4] until H is selected.
Press [5] until L is selected.
Press [6] until H is selected.
Press [7] until L is selected.
Press [8] until H is selected.
Press the function key [EXIT]

Press DOWN arrow [⇓] The backlit box is now again at the top of the list adjacent to "Test Step: 2 ".
Press [MENU] to exit program mode.

Save this example to memory before a TEST is run. First set preset functions and then perform Offset and Get Cs as all three functions are saved in memory with the test setup.

Set Preset (¶2.6)
Perform Offset (¶2.7.1)
Perform Get Cs (¶2.7.2)
Press the function key [MEMORY]
The backlit box is adjacent to location 1: "1. (0) : ".
Press DOWN arrow [⇓] to move backlit box to selected location (5 for this example).
Press the function key [STORE]

Use numeric keypad to name memory location (up to 13 alpha-numeric characters).
Press [ENTER] then [NEXT CHAR.] to move cursor to next character.
Name this setup "EXSCAN".
Press [ENTER] when finished: "5. (_2) : EXSCAN ".
Message: "STORE? Press ENTER to continue"
Press [ENTER]
Press MENU
Press the function key [TEST]

External Scanner Connection – Multi-Point Hipot

Figure 3-13 illustrates a multi-point Hipot/IR setup. The Guardian 6100 Plus with is connected in a chain with two external Guardian 5000-01 scanners.

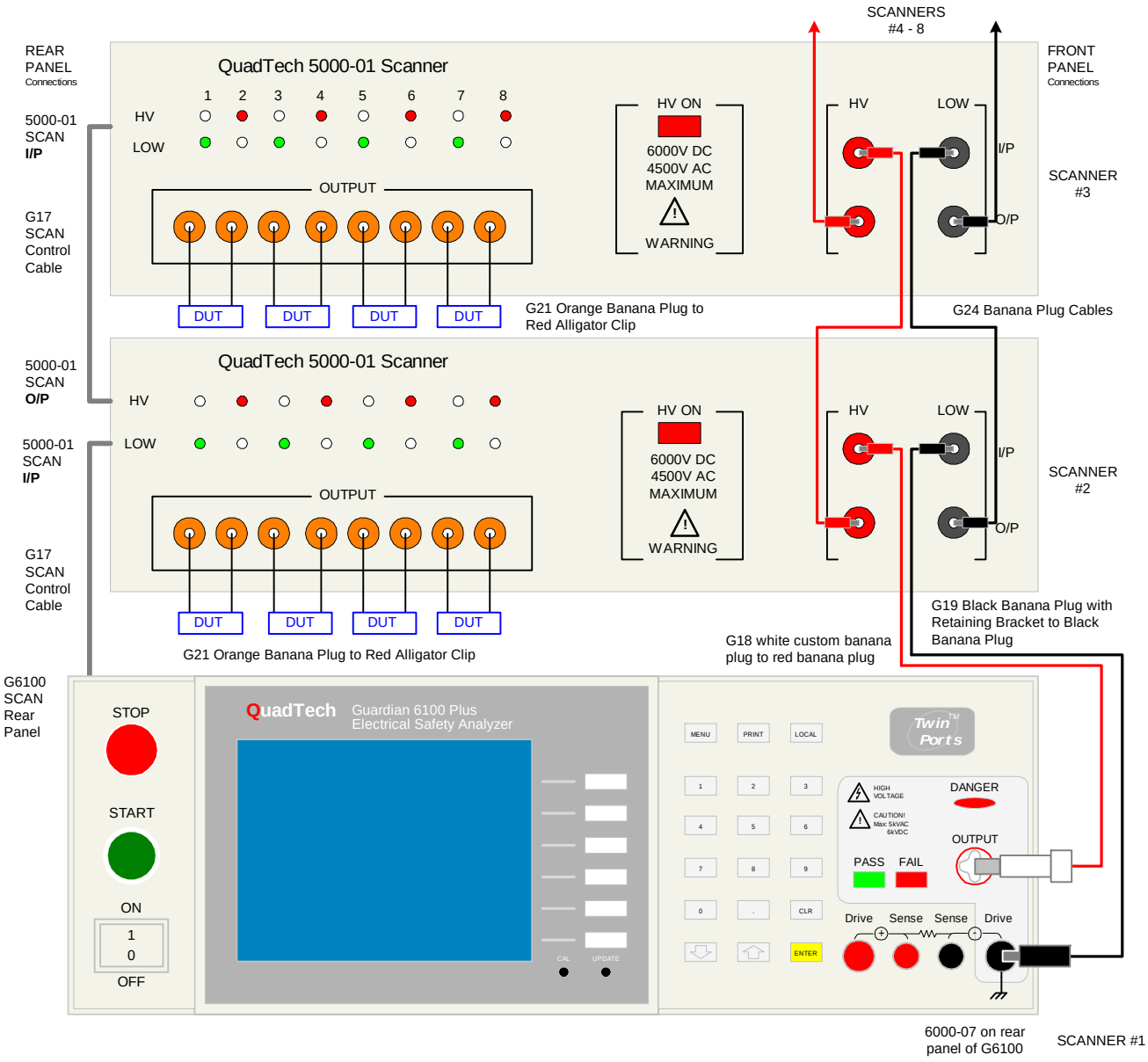

Figure 3-13: G6100 Plus Connection to 5000-01 Multiple External Scanners (AC/DC Hipot & Insulation Resistance Tests)

External Scanner Connection – Multi-Point Ground Bond

Figure 3-14 illustrates the Guardian 6100 Plus connected to an external Guardian 5000-02 scanner for multi-channel Ground Bond testing. The external scanner must be connected to the FRONT panel output connectors of the G6100 Plus. The 6000-07 Hipot/Line Leakage internal scanner is shown installed but is not used in this GB application.

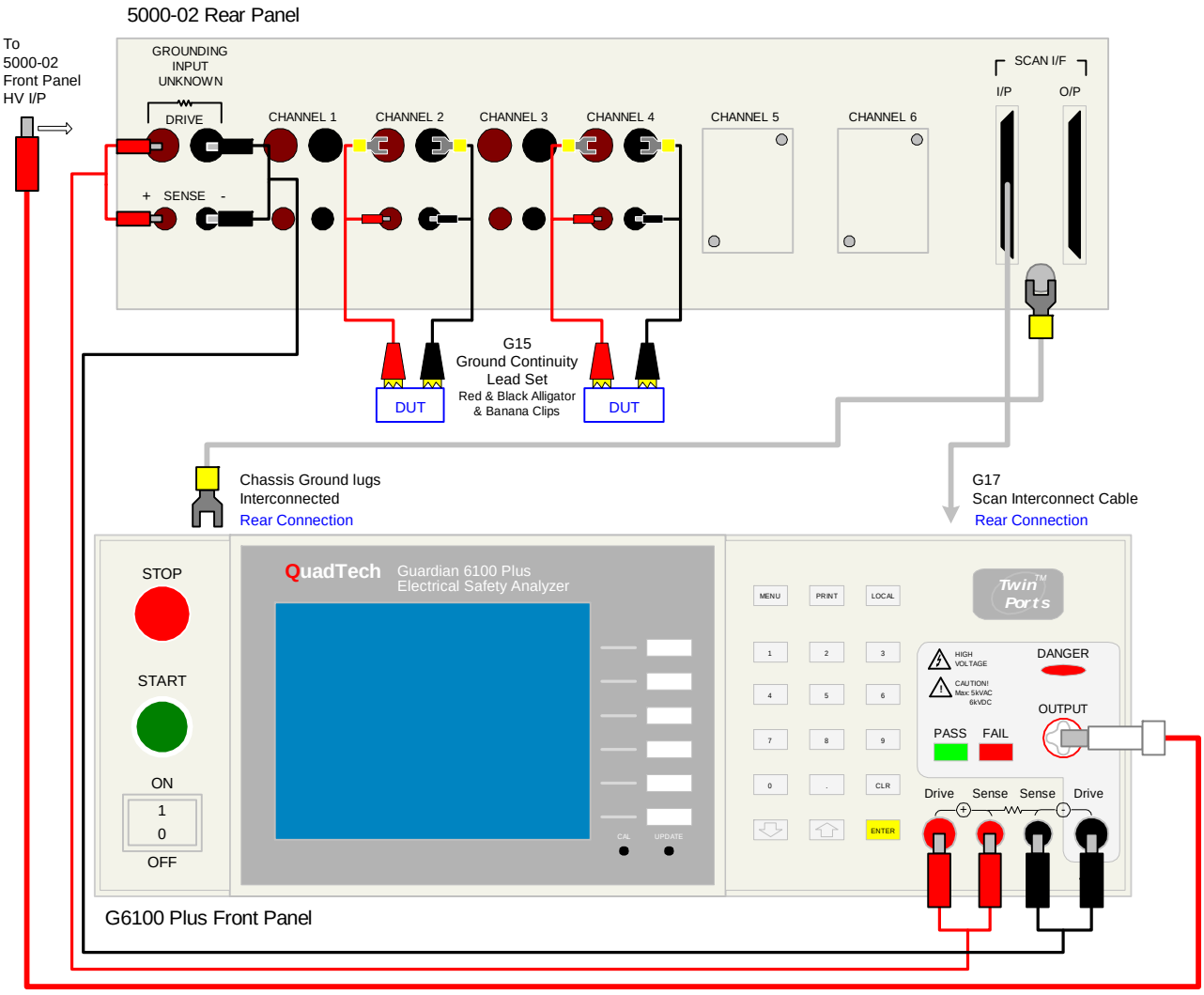

Figure 3-14: G6100 Plus Connection to 5000-02 External Scanner

3.6 Troubleshooting

Listed herein are some common errors and suggested methods to resolve the problem.

High Limit Failures:
1. Check DUT ensure that it is not faulty
2. Remove DUT and perform test with cables only.
If the test passes, ensure offset LED is on (if this function is being used), if offset LED is off, possible cause of failure is the additional leakage from offset being off. Perform offset function and repeat testing.
If offset is either on or not being utilized, confirm the Guardian is measuring properly using a standard resistor. Use ohms law to calculate what the current should be. For instance if your test is 2200V, high limit set to 5mA. Attach a 500kohm resistor. The display should read 4.4mA (give or take error in resistance)

Test fails with no cables attached:
Ensure low limit is off.
Ensure offset LED is on (if this function is being used).
Ensure high limit is programmed correctly.
Change ranges by adjusting the high limit.
If test passes on a different range, it is likely that one of the range relays has failed.

Low Limit Failures:
Ensure the DUT is connected
Ensure the Power Switch is enabled on DUT.
Check cabling by using resistor standard as described for verifying high limit.

Ground Bond Failures:
Short Ground Bond test leads together (or by method shown in Figure 2-15: Offset Short using G30 & G15), with DUT removed. Ensure that Ground Bond test will pass with test leads connected.
If not, try new set of test leads

Hipot Test fails during Ramp:
As stated, the high and low limits will not be applied during ramp. There are cases where the test will fail during ramp. IF the leakage current exceeds the range limitation a failure may occur during ramp.
For instance, the high limit is set to 2.5mA, if the leakage exceeds 3mA during ramp the test will fail. The display may read UUUUU, this simply means the Guardian can not measure the current, it is out of range.

No Display:
Adjust contrast by pressing [MENU], [1] and the [↓] or [↑] arrow on the keypad so the backlit box is to the right of Contrast.
Use the function keys [UP] or [DOWN] to increase or decrease the contrast. The display Contrast is adjustable from 1 – 31. A value of 1 is brightest , a value of 31 is darkest. The default setting for Contrast is 17.

No Buzzer:
Ensure Beeper is turned on.
To access Beeper Volume, press [MENU], [1] and the [↓] or [↑] arrow on the keypad so the backlit box is to the right of Beeper Volume.
Use the function keys [LOW], [MEDIUM], [HIGH] or [OFF] to increase or decrease the volume. The Beeper Volume can be set to OFF or to sound in a High, Medium or Low tone. The default setting for Beeper Volume is HIGH.

Press [START] and nothing happens:
Press [STOP] followed by [START]
Ensure there is a valid program on the standby menu. Voltage may not equal 0.
Ensure Interlock on the back panel is connected
Ensure that Stop is not shorted to common on the back panel

Section 4 : Service & Calibration

4.1 General

Our warranty (at the front of this manual) attests to the quality of materials and workmanship in our products. If malfunction should be suspected or other information be desired, applications engineers are available for technical assistance. Application assistance is available in the U.S. by calling 800-253-1230 and asking for Applications Support. For support outside of the United States, please contact your local QuadTech Distributor.

4.2 Instrument Return

Before returning an instrument to QuadTech for Service please obtain an online Return Materials Authorization Number (RMA#). This number, when placed on the outside of the shipping package, will speed processing at our Service Lab and will serve as a reference number for the time your unit is at QuadTech. Please contact our **Customer Care Center (CCC)** at **800-253-1230** for additional support. The CCC phone line is staffed from 8:00am to 5:00pm (EST).

It will be necessary to include a Purchase Order Number and credit card information to insure expedient processing, although units found to be in warranty will be repaired at no-charge. For any questions on repair costs or shipment instructions please contact our CCC Department at the above number. To safeguard an instrument during storage and shipping please use packaging that is adequate to protect it from damage, i.e., equivalent to the original packaging and mark the box "Delicate Electronic Instrument". Please follow online instructions for shipping materials back to QuadTech.

4.3 Calibration

Calibration of the Guardian 6100 Plus is recommended on an annual basis. If the unit is returned to QuadTech for factory calibration refer to paragraph 4.2 for instructions. Using the calibration procedure below the instrument can be calibrated by a qualified service person if traceable calibration equipment and standards are available. **The instrument should be powered up for a minimum of 1 hour before calibration to ensure maximum stability.**

Table 4-1 : Calibration Equipment

Equipment	Requirements
AC/DC High Voltage Voltmeter	Measure Range: 0 to 4kV, 0.1% accuracy
AC/DC Current Meter	Measure Range: 0 to 10mA, 0.15% accuracy
IR Standards Box	Tool # 01-1395 or equivalent
1GΩ Resistance Standard	250V
100MΩ Resistance Standard	500V
10MΩ Resistance Standard	500V & 1000V; 1200V, 0.1mA, .25W
10MΩ Resistance Standard	200W
50kΩ Resistance Standard	200W
150kΩ Resistance Standard	100W
420kΩ Resistance Standard	50W

4.3.1 Calibration Procedure

Table 4-2 details the two-part calibration procedure for the G6100 Plus instrument.

Table 4-2 : Calibration Parameters

TEST		RANGE		CAL. POINT
DEVICE CALIBRATION				
CAL 1	ACV	5kV	Offset	100 V
CAL 2	ACV	5kV	Full	4.000kV
CAL 3	DCV	6kV	Offset	100 V
CAL 4	DCV	6kV	Full	4.000kV
CAL 5	IRV	1kV	Offset	100 V
CAL 6	IRV	1kV	Full	1.000kV
CAL 7	ACA	3mA	Offset	0.12mA
CAL 8	ACA	3mA	Full	2.5mA
CAL 9	ACA	40mA	Offset	2.5mA
CAL 10	ACA	40mA	Full	25mA
CAL 11	DCA	3mA	Offset	0.12mA
CAL 12	DCA	3mA	Full	2.5mA
CAL 13	DCA	12mA	Offset	2.5mA
CAL 14	DCA	12mA	Full	10mA
CAL 15	GBA	30A	Offset	3A
CAL 16	GBA	30A	Full	25A
CAL 17	GBV	8V	Offset	0.3V
CAL 18	GBV	8V	Full	3V
CAL 19	AC Arc	40mA	-----	5mA
CAL 20	DC Arc	12mA	-----	5mA
CAL 21	IRA	100	Offset	Open
CAL 22	IRR	250V	Range 1	1GΩ
CAL 23	IRR	500 V	Range 2	100MΩ
CAL 24	IRR	500 V	Range 3	10MΩ
CAL 25	IRR	1000V	Range 4	10MΩ
LC BOARD CALIBRATION				
CAL 1	LC	1V	Offset	0.08V
CAL 2	LC	1V	Full	0.8V
CAL 3	LC	10V	Offset	0.8V
CAL 4	LC	10V	Full	8V
CAL 5	LCV	300V	Offset	20V
CAL 6	LCV	300V	Full	200V
CAL 7	LCA	1A	Offset	0.08A
CAL 8	LCA	1A	Full	0.8A
CAL 9	LCA	10A	Offset	0.8A
CAL 10	LCA	10A	Full	8A

To Enable Calibration:

The Guardian 6100 Plus instrument requires a minimum 30-minute warm up period prior to calibration. With the instrument in standby status ([STOP] button previously pressed and no lights flashing) remove the front panel calibration seal and push (using tip of small screw driver) the recessed switch through the hole in the front panel labeled **Cal-Enable** (to the **in** position).

From Menu display:
Select item 3 "CALIBRATION" by Pressing [3] [ENTER] Display reads "password".
Press [7] [9] [3] [1] Enter
Select [DEVICE]

4.3.1.1 AC Voltage Calibration

Connect the OUTPUT terminal of the Guardian 6100 Plus to the input terminal of the AC/DC high voltage meter. Connect the RTN/LOW terminal of the Guardian to the GND terminal of the voltmeter. Set the voltmeter to AC and 200V range.

Press [UP] to go to CAL step 1. (ACV 5kV Offset 100V)
Press [STOP]
Press [START]
Using keypad enter the reading from the voltmeter followed by the [ENTER].
Press [STOP] to accept reading.
Press [UP] to go to CAL step 2. (ACV 5kV Full 4.000kV)
Change the range on the voltmeter to 20kV.

Press [START]
Using keypad enter the reading from the voltmeter followed by the [ENTER].
Press [STOP] to accept reading.

4.3.1.2 DC Voltage Calibration

Change the setting on the Valhalla to DC and 200V range.
Press [UP] to go to CAL step 3. (DCV 6kV Offset 100V)
Press [STOP]
Press [START]
Using keypad enter the reading from the voltmeter followed by the [ENTER].
Press [STOP] to accept reading.
Press [UP] to go to CAL step 4. (DCV 6kV Full 4.000kV)
Change the range on the voltmeter to 20kV.
Press [STOP]
Press [START]
Using keypad enter the reading from the voltmeter followed by the [ENTER].
Press [STOP] to accept reading.

4.3.1.3 IR Voltage Calibration

Change the setting on the Valhalla to the 200V range.

Press [UP] to go to CAL step 5. (IRV 1kV Offset 100V)
Press [STOP]
Press [START]
Using keypad enter the reading from the voltmeter followed by the [ENTER].
Press [STOP] to accept reading.
Press [UP] to go to CAL step 6. (IRV 1kV Full 1.000kV)

Change the range on the voltmeter to 2kV.
Press [STOP]
Press [START]
Using keypad enter the reading from the voltmeter followed by the [ENTER].
Press [STOP] to accept reading.

4.3.1.4 AC Current Calibration

Connect the OUTPUT terminal of the Guardian 6100 Plus to a resistance box or resistance standard. Connect an AC/DC current meter in series between the resistance (box) and RTN/LOW terminal. Set the meter to AC current. Table 4-3 lists the loads for the current calibration steps.

Table 4-3: Resistance Loads

Mode	Step #	Voltage	Calibration Range		Calibration Point	Resistance (Load)
ACA	CAL 7	1200 V	3mA	Offset	0.12mA	10MΩ
ACA	CAL 8	1200 V	3mA	Full	2.5mA	420kΩ
ACA	CAL 9	1200 V	40mA	Offset	2.5mA	420kΩ
ACA	CAL 10	1200 V	40mA	Full	25mA	50kΩ
DC	CAL 11	1200 V	3mA	Offset	0.12mA	10MΩ
DC	CAL 12	1200 V	3mA	Full	2.5mA	420kΩ
DC	CAL 13	1200 V	12mA	Offset	2.5mA	420kΩ
DC	CAL 14	1200 V	12mA	Full	10mA	150kΩ

To continue calibration from step 6 proceed as follows:

Press [UP] to go to CAL step 7. (ACA 3mA Offset 0.12mA)
Press [STOP]
Press [START]
Using keypad enter the reading from the current meter followed by the [ENTER].
Press [STOP] to accept reading.

Press [UP] to go to CAL step 8. (ACA 3mA Full 2.500mA)
Press [STOP]
Press [START]
Using keypad enter the reading from the current meter followed by the [ENTER].
Press [STOP] to accept reading.

Press [UP] to go to CAL step 9. (ACA 40mA Offset 2.500mA)
Press [STOP]
Press [START]
Using keypad enter the reading from the current meter followed by the [ENTER].
Press [STOP] to accept reading.

Press [UP] to go to CAL step 10. (ACA 40mA Full 25mA)
Press [STOP]
Press [START]
Using keypad enter the reading from the current meter followed by the [ENTER].
Press [STOP] to accept reading.

4.3.1.5 DC Current Calibration

Make sure to change the meter's setting to DC current prior to STEP 11. Ensure the Current meter is set to the lowest range possible, for each step.

To continue calibration from step 10 proceed as follows:

Press [UP] to go to CAL step 11. (DCA 3mA Offset 0.12mA)
Press [STOP]
Press [START]
Using keypad enter the reading from the current meter followed by the [ENTER].
Press [STOP] to accept reading.

Press [UP] to go to CAL step 12. (DCA 3mA Full 2.500mA)
Press [STOP]
Press [START]
Using keypad enter the reading from the current meter followed by the [ENTER].
Press [STOP] to accept reading.

Press [UP] to go to CAL step 13. (DCA 12mA Offset 2.500mA)
Press [STOP]
Press [START]
Using keypad enter the reading from the current meter followed by the [ENTER].
Press [STOP] to accept reading.

Press [UP] to go to CAL step 14. (DCA 12mA Full 10mA)
Press [STOP]
Press [START]
Using keypad enter the reading from the current meter followed by the [ENTER].
Press [STOP] to accept reading.

4.3.1.6 Ground Bond Current Calibration

Table 4-4 lists the loads for the Ground Bond tests. Connect the Drive & Sense terminals of the Guardian 6100 Plus to the 1mΩ resistance standard as shown in Figure 4-1. Connect the AC voltage meter to the Sense + and Sense – terminals of the Guardian 6100 Plus.

Table 4-4: Ground Bond Loads

Mode	Step #	Calibration Range		Calibration Point	Resistance (Load)
GBA	CAL 15	30A	Offset	3A	1mΩ
GBA	CAL 16	30A	Full	25A	100mΩ
GBV	CAL 17	8V	Offset	0.3V	100mΩ
GBV	CAL 18	8V	Full	3V	100mΩ

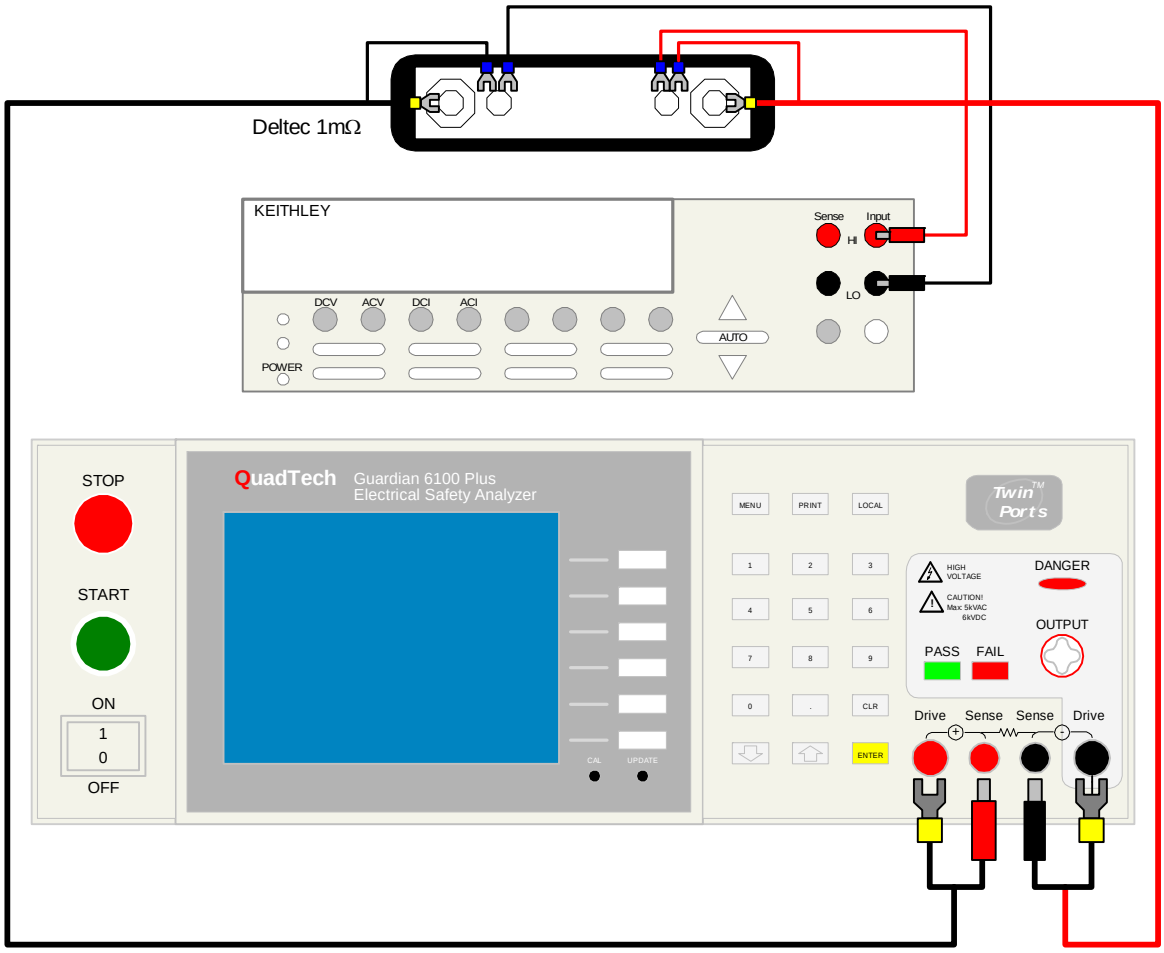

Figure 4-1: Connection to 1mΩ Standard

Press [UP] to go to CAL step 15. (GBA 30A Offset 3A)

Press [STOP]
Press [START]
Using keypad enter the current reading (reading from the voltmeter/ resistor standard value) followed by the [ENTER]. (I=V/R)
Press [STOP] to accept reading.

Press [UP] to go to CAL step 16. (GBA 30A Full 25A)
Change the load to 100mΩ as shown in Figure 4-2.
Press [STOP]
Press [START]
Using keypad enter the current reading (reading from the voltmeter/ resistor standard value) followed by the [ENTER]. (I=V/R)
Press [STOP] to accept reading.

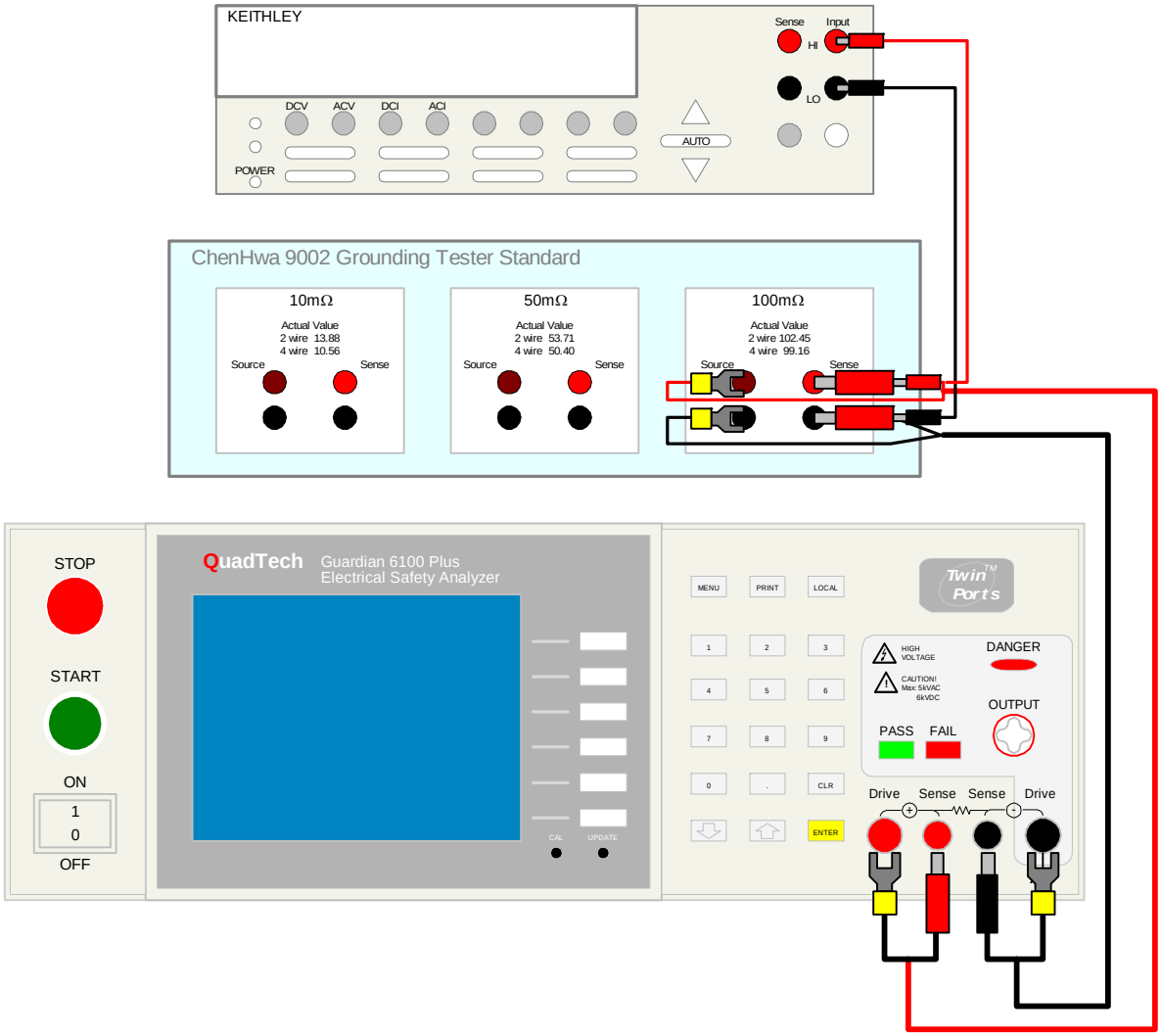

Figure 4-2: Connection to 100mΩ Standard

4.3.1.7 Ground Bond Voltage Calibration:

With 100mΩ load attached:

Press [UP] to go to CAL step 17. (GBV 8V Offset 0.3V)
Press [STOP]
Press [START]
Using keypad enter the voltage reading from the voltmeter followed by [ENTER].
Press [STOP] to accept reading.

Press [UP] to go to CAL step 18. (GBV 8V Full 3V)
Press [STOP]
Press [START]
Using keypad enter the voltage reading from the voltmeter followed by [ENTER].
Press [STOP] to accept reading.

4.3.1.8 AC and DC ARCing Calibration

The next two steps (19 and 20) are used to calibrate ARC. These two steps will not be performed. Press [UP] [UP] , so that the display reads IRA Open.

4.3.1.9 IR Resistor Calibration

Table 4-5: IR Resistance Loads

TEST	RANGE	CAL. POINT	TEST	Resistance Load
CAL 21	IRA	100	Offset	Open
CAL 22	IRR	250V	Range 1	1GΩ
CAL 23	IRR	500 V	Range 2	100MΩ
CAL 24	IRR	500 V	Range 3	10MΩ
CAL 25	IRR	1000V	Range 4	10MΩ

To continue with CAL step 21 remove any load boxes attached.

Press [UP] to go to CAL step 21. (IRA 100 Offset Open)
Press [STOP]
Press [START]
The Guardian will run through an open circuit test from 100 – 1000V for approximately 50 seconds.
Press [STOP] when complete.

Continue with steps 22 -25 by attaching the dummy load box outlined in Table 4-5 between the High voltage output and the return.

Press [UP] to go to CAL step 22. (IRR 250V Range1 1GΩ)
Press [STOP]
Press [START]
Enter the value of the resistor standard followed by [ENTER]
Press [STOP]

Press [UP] to go to CAL step 23. (IRR 500V Range2 100MΩ)
Press [STOP]
Press [START]
Enter the value of the resistor standard followed by [ENTER]
Press [STOP]

Press [UP] to go to CAL step 24. (IRR 500V Range3 10MΩ)
Press [STOP]
Press [START]
Enter the value of the resistor standard followed by [ENTER]
Press [STOP]

Press [UP] to go to CAL step 25. (IRR 1000V Range4 10MΩ)
Press [STOP]
Press [START]
Enter the value of the resistor standard followed by [ENTER]
Press [STOP]

[DEVICE] Calibration is complete.

Press [EXIT]

Now to calibrate the Leakage Current scanner. Turn OFF the G6100 Plus instrument. Remove the 6000-07 scanner and switch the [JMP1] switch on the rear of the 6000-07 PC board to "CAL". This switch is hardware-protected so no calibration data will be lost.

Turn ON the G6100 instrument
In Main Menu, press [3] = CALIBRATION
Display prompts: "PASSWORD: _____"
Press [7][9][3][1] [ENTER]
Press [LC BOARD] to enter Leakage Current Calibration.

The Leakage Current (LC) calibration is divided into two parts – the meter calibration and the power meter calibration.

4.3.1.10 LC Meter Calibration

Connect an AC voltage source (Freq = 60Hz) between the N-IN terminal on the 6000-07 scanner and DRIVE- on the GB Floating terminals.

Press [UP] to go to CAL step 1. (LC 1V Offset 0.08V)

Press [STOP]
Press [START]
Using keypad enter the reading from the voltmeter followed by [ENTER].
Press [STOP] to accept reading.

Press [UP] to go to CAL step 2. (LC 1V Full 0.8V)

Press [STOP]
Press [START]
Using keypad enter the reading from the voltmeter followed by [ENTER].
Press [STOP] to accept reading.

Press [UP] to go to CAL step 3. (LC 10V Offset 0.8V)

Press [STOP]
Press [START]
Using keypad enter the reading from the voltmeter followed by [ENTER].
Press [STOP] to accept reading.

Press [UP] to go to CAL step 4. (LC 10V Full 8V)

Press [STOP]
Press [START]
Using keypad enter the reading from the voltmeter followed by [ENTER].
Press [STOP] to accept reading.

4.3.1.11 LC Power Meter Calibration

LC Voltage 300V Offset and Full

Connect an AC voltage source (Freq = 60Hz) between the L-IN terminal and the N-IN terminal on the 6000-07 scanner.

Press [UP] to go to CAL step 5. (LCV 300V Offset 20V)

Press [STOP]
Press [START]
Using keypad enter the reading from the voltmeter followed by [ENTER].
Press [STOP] to accept reading.

Press [UP] to go to CAL step 6. (LCV 300V Full 200V)

Press [STOP]
Press [START]
Using keypad enter the reading from the voltmeter followed by [ENTER].
Press [STOP] to accept reading.

LC Current 1A Offset and Full

Connect an AC current source (Freq = 60Hz) between the L-IN terminal and the L-OUT terminal on the 6000-07 scanner.

Press [UP] to go to CAL step 7. (LCA 1A Offset 0.08A)

Press [STOP]
Press [START]
Using keypad enter the reading from the ammeter followed by [ENTER].
Press [STOP] to accept reading.

Press [UP] to go to CAL step 8. (LCA 1A Full 0.8A)

Press [STOP]
Press [START]
Using keypad enter the reading from the ammeter followed by [ENTER].
Press [STOP] to accept reading.

LC Current 10A Offset and Full

SAME connection of an AC current source (Freq = 60Hz) between the L-IN terminal and the L-OUT terminal on the 6000-07 scanner.

Press [UP] to go to CAL step 9. (LCA 10A Offset 0.8A)

Press [STOP]
Press [START]
Using keypad enter the reading from the ammeter followed by [ENTER].
Press [STOP] to accept reading.

Press [UP] to go to CAL step 10. (LCA 10A Full 8A)

Press [STOP]
Press [START]
Using keypad enter the reading from the ammeter followed by [ENTER].
Press [STOP] to accept reading.

[LC BOARD] calibration is complete.

4.3.1.12 Finalize Calibration

When all calibration steps are complete:

Press [EXIT]
Release the [CAL ENABLE] switch to the **OUT** position using the tip of a small screwdriver.
Cover [CAL ENABLE] switch with a calibration seal.